

University of Alberta

HANTAVIRUS IN ALBERTA'S BOREAL FOREST:

**Reducing the occupational health risk of exposure for farmers and
forest professionals**

by

Komali Naïdoo



**A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment
of the requirements for the degree of Master of Science**

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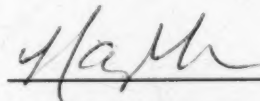
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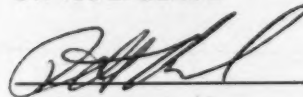
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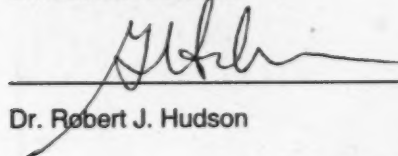
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Abstract

Hantavirus pulmonary syndrome (HPS) is a rare and often fatal disease in Canada, particularly in the province of Alberta. This research study applied grounded theory methods to uncover an interactive decision-making process used by farmers and forest professionals to gauge their level of precautionary action when faced with potential occupational exposures to deer mice and their detritus.

The media, colleagues, community members, and professionals were cited as major ways individuals gained hantavirus knowledge. Barriers to taking precautionary action were the effectiveness, lack of preparedness, practicality, and the nature of their physical work environments.

Recommendations for risk reduction are to continue disseminating hantavirus information in the spring and fall; promote multi-purpose precautionary measures, that is, those that will protect against more than one occupational disease; and identify specific measures for specific occupational tasks. Providing support for those who contracted hantavirus and their families was also recommended.

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CHAPTER 1: BACKGROUND OVERVIEW

INTRODUCTION

This chapter provides an overview of Hantavirus Pulmonary Syndrome (HPS). Its intent is to first discuss HPS in the context of an emerging infectious disease and then provide some background information. Hantavirus Pulmonary Syndrome is described, as well as its clinical characteristics, frequency and distribution of HPS cases in Alberta and Canada, and recommended preventive measures. This process will provide a background overview for the chapters to follow.

EMERGING INFECTIOUS DISEASES

New and resurgent infectious diseases have occurred throughout history (Burnet & White, 1972). Infectious disease is defined by Last (1988) as "an illness due to a specific infectious agent or its products from an infected person, animal, or reservoir to a susceptible host, either directly or indirectly through an intermediate plant or animal host, vector, or the inanimate environment." Microbes and viruses have continuously evolved with their changing environments by adapting in response to factors such as nutrient shortages, hostile immune systems and antibiotics (McMichael, 1998). Since the life cycles of microbes and viruses are so short they can replicate in a comparatively short span of time, and their ability to adapt to changing environments is great. This continuous and rapid adaptation can cause patterns of infectious diseases to change on a global scale (Lederberg et al. 1992; Wilson, 1995).

"Emerging infectious diseases", a component of infectious diseases, have been defined by the Institute of Medicine and the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia as "diseases of infectious origin with an incidence that has increased within the past two decades or threatens to increase in the near future" (Centers for Disease Control and Prevention, 1994; Lederberg et al., 1992). Some of the diseases are associated with newly discovered infectious agents, while others are well-known conditions that have been rapidly increasing in incidence (Strausbaugh, 1997). In many cases, the disease may have been around for some time, but the microbial cause and/or

recognition of the disease was discovered only within the past two decades (Kaplan, 1997).

Hantavirus Pulmonary Syndrome (HPS) has been classified by the CDC as an "emerging infectious disease" (Strausbaugh, 1997). It is a good example of an emerging infectious disease that has been around for some time but only recently recognised. Hantaviruses, in general, are classic "emerging viruses", because of their tendency to appear, sometimes explosively, in new populations in which they are unexpected (Hjelle et al., 1994). They have re-surged in several European nations, and most notably in the former Soviet Union, Yugoslavia, as well as North and South America (Epstein, 1997). The re-examination of historic outbreaks has led to some reclassifications of epidemics. For example, a recent reassessment of the mysterious 'English Sweating Sickness' epidemics of the sixteenth century concluded that it may have actually been HPS (Thwaites et al., 1997).

In the past two decades there has been an emergence of 28 viruses. Some factors that have been associated with the emergence of these 28 viruses have been related to recognition of viruses, genetic change, immunosuppression, drug resistance, public health deterioration, technology change, environmental change, food hygiene, human behaviour change and travel. The top three factors identified as chief causative factors associated with emerging infectious disease were environmental change, recognition of viruses, and human behaviour change (Lederberg et al, 1992).

It is necessary and important to address issues of emerging infectious diseases because of their potential public health implications in terms of their recognition, surveillance, health promotion and prevention, and strategies for dealing with future emerging infectious diseases. This research study will focus on prevention.

HANTAVIRUS PULMONARY SYNDROME (HPS)

What is Hantavirus and Hantavirus Pulmonary Syndrome?

Hantaviruses are rodent-borne RNA viruses (Huang et al., 1996; Lee et al., 1978). They belong to the family *Bunyaviridae* (Schmaljohn et al., 1985), and many in North America

are classified within the genus *Hantavirus* (Chu et al., 1994; Xiao et al., 1994). Worldwide, there are a number of known hantavirus serotypes. Each typically have different rodent hosts, geographical distributions, and degrees of pathogenicity to humans. With few exceptions, each known hantavirus genotype has a single specific rodent species as its primary reservoir (McKee et al., 1991; Childs et al., 1994; Morzunov et al., 1995; Rawlings et al., 1996; Rollin et al., 1995; Torrez-Martinez & Hjelle, 1995; Peters, 1997; Mills & Childs, 1998; Shope, 1999). Some studies suggest that New World hantaviruses are very old and may have arrived in North America over 20 million years ago (Yates et al., 1998). Genetic data are consistent with the hypothesis that hantaviruses and their rodent reservoirs may have co-evolved over a long period of time (Hjelle et al., 1994; Nichol et al., 1993; Shope, 1999; Spiropoulou et al., 1994).

In North America there have been a number of hantaviruses identified. However, the specific hantavirus of interest for this study is the Sin Nombre Virus (SNV). This virus is found throughout North and South America, and has been identified as the cause of human cases of HPS in Canada. There may also be a variant on SNV, an SNV-like hantavirus, found in eastern Canada (Langlois, 1996).

In North America, SNV is the primary etiologic agent for Hantavirus Pulmonary Syndrome (HPS). Investigations of SNV have found that the deer mouse, *Peromyscus maniculatus*, serve as the principal reservoir or carrier of the Sin Nombre Virus (McKee et al., 1991; Avsic-Zupanc et al., 1992; Nichol et al., 1993; Childs et al., 1994; Hjelle et al., 1994; Warner, 1996). Deer mice are prevalent throughout the United States and Canada, except in the southeast and along the eastern seaboard of the United States (Whitaker, 1980).

HPS generated great interest in the New World hantaviruses with an outbreak of cases in the southwestern region (the Four Corners Region) of the United States in 1993 (Duchin et al., 1994; Hjelle et al., 1994; Simonsen et al., 1995; Strausbaugh, 1997). This is the area where the states of Colorado, New Mexico, Utah, and Arizona share a common border. At the time of this outbreak HPS was thought to be a new disease. However, it was quickly recognised as one that has been in North America for some time. The existence of pathogenic and anti-genetically related viruses that preceded the

recognition of this syndrome and the genetic diversity of the virus suggest the outbreak in 1993 was not due to a newly emergent or virulent virus, but to changes in the rodent-host interaction. Environmental and ecological changes, such as an increase in rainfall and resulting increases in food supply such as grasses, nuts, and seeds led to substantial growth in the deer mice populations, and may have played a key role in the 1993 outbreak (Epstein, 1997).

Clinical Definition and Characteristics of Hantavirus Pulmonary Syndrome

Hantaviruses from around the world have been known to cause three distinct clinical syndromes in humans: Hemorrhagic Fever with Renal Syndrome (HFRS) found in Asia and Eastern Europe; Nephropathia Epidemica (NE) found in Scandinavia and Central Europe; and Hantavirus Pulmonary Syndrome (HPS) the main clinical syndrome found in North and South America (Epstein, 1997). Retrospective clinical information and testing of sera from survivors, as well as archived samples from rodents and humans, provided evidence for cases in the United States as far back as 1959 (Frampton et al., 1995). In Canada, the first retrospective case was in 1989 (Drebot et al., 2000).

Often the clinical definition characterises Hantavirus Pulmonary Syndrome (HPS) as having a "rapid, dramatic clinical progression and high case-fatality rates" (Kitsutani et al., 1999). HPS is a severe form of respiratory distress typically characterised by high fever, chills, severe muscular pain, malaise (vague feeling of body discomfort), nausea, vomiting, dizziness, cough, and chest pain (Peters, 1997; Kitsutani, 1999). It affects previously healthy individuals and is associated with severe and progressive respiratory failure, shock, and in many cases, fatality (Simonsen et al., 1995).

The average incubation period is typically two to three weeks, although incubation periods as short as six days and as long as five weeks have also been reported (Pflieger & Khan, 1997). Patients typically seek medical attention after a relatively short febrile prodrome of three to five days. This is essentially a short fever episode of three to five days, which indicates the onset of disease. In addition to fever and myalgias (muscular pain), early symptoms of the hantavirus disease onset usually include headache, chills, dizziness, nausea, vomiting, and other gastrointestinal symptoms (Duchin et al., 1994; Khan et al., 1996). Malaise, diarrhea, shortness of breath, and light-headedness have

also been reported, as have arthralgias (pain in joints), back pain, and abdominal pain (Pflieger & Khan, 1997). Patients are often misdiagnosed during the early stage of the disease since differentiating symptoms such as cough and tachypnea (very rapid respiration) generally do not develop until the end of the prodromal phase (Pflieger & Khan, 1997).

This initial phase is followed 4 to 6 days later by abrupt onset of dyspnea (laboured or difficult breathing) and hypoxia (reduction of oxygen supply to the tissues), typically associated with non-cardiac pulmonary edema and respiratory failure, requiring mechanical ventilation, hospitalisation and intensive-care management (Duchin et al., 1994; Hallin et al., 1996).

The symptoms of HPS may be easily confused with those of sepsis and severe pneumonia caused by group A streptococci (such as *Streptococcus pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila*, influenza A), or viral pneumonia agents such as adenoviruses. The lack of sore throat and nasal symptoms distinguishes HPS from influenza A, and the lack of pulmonary lobar infiltrates and chest pain usually distinguishes HPS from pneumococcal pneumonia. Other sources of diagnostic confusion, depending on the patient's history, are septicemic plague, tularemia, leptospirosis, Q fever, ehrlichiosis, coccidioidomycosis, histoplasmosis, and diffuse pulmonary hemorrhage such as occurs in Goodpasture's syndrome (Pflieger & Khan, 1997).

A few patients in the United States have had acute SNV infections resulting in illnesses less severe than HPS. These patients had characteristic HPS-like prodromal symptoms of high fever, headache, and myalgia. Some of the other typical features of HPS such as malaise, nausea, vomiting, dizziness, cough, and chest pain were also observed (Simonsen et al., 1995). In these mild cases of HPS, patients did not develop severe respiratory distress, pulmonary edema, and hypotension or shock; the hallmarks of HPS (Kitsutani et al., 1999). Thus, the development of dyspnea (laboured or difficult breathing) signals the onset of severe pulmonary edema and a more severe case of HPS. It is unclear why these hallmark characteristics did not develop in these mild cases of HPS. Like the hantaviruses that cause a clinical spectrum of haemorrhagic

fever with renal syndrome, less pathogenic strains of SNV or other American hantaviruses may not yet have been characterised (Kitsutani et al., 1999).

The diagnosis of HPS is usually confirmed by serologic testing for hantavirus SNV immunoglobulin IgM and IgG, because results can be obtained in a relatively short period of time (within a day) as opposed to three or four days if reverse transcriptase polymerase chain reaction (RT-PCR) or immunohistochemical analysis (IHC) was done (Kitsutani et al., 1999). Thus, a confirmed case is "a person with clinical illness and laboratory confirmation of infection." (Drebot et al., 2000, p. 65).

There is no antiviral therapy for HPS that has been proven effective. However, currently clinical trials with ribavirin are being undertaken (Drebot et al., 2000). Treatment of patients with HPS remains supportive in nature. With early intensive care being imperative and ensuring that electrolyte, pulmonary, and hemodynamic abnormalities are corrected immediately (Pflieger & Khan, 1997).

Hantavirus Pulmonary Syndrome (HPS) in Canada and Alberta

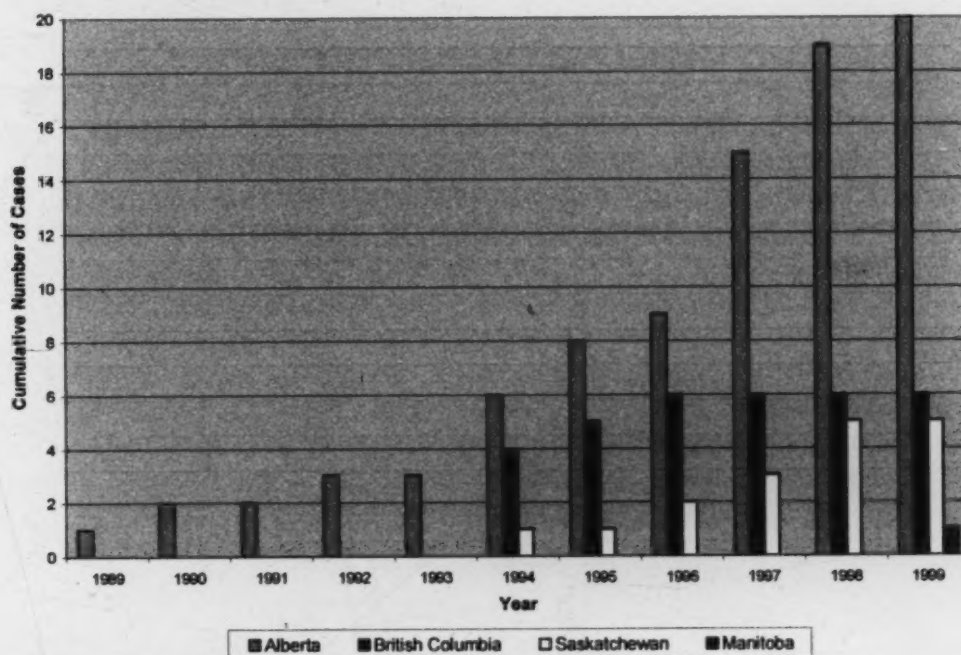
Hantavirus pulmonary syndrome (HPS) is a rare disease in Canada and Alberta (Werker et al., 1998). Although currently a rare disease it is an important area to be studied, because of the high mortality rate. Approximately a third of the cases are fatal. The following section provides frequency and distribution information about the HPS cases in Alberta and Canada.

A. HPS in Canada

Confirmed cases of HPS are distributed unequally across the four western provinces, and suspected cases in other provinces have not been confirmed with appropriate laboratory investigations. The first recognised Canadian case of HPS occurred in British Columbia in 1994 (Health Canada, 1995). In Alberta, the first confirmed case of HPS, a fatal one, became known in October of 1994 (Health Canada, 1995). The first confirmed case in Saskatchewan was also identified in 1994. However, it was only in 1999 that the first HPS case occurred in Manitoba (Health Canada, 1995; Werker et al., 1998; Drebot et al., 2000).

There were 32 cases in Canada from 1989 to 1999. Figure 1-1 illustrates the frequency and distribution of these cases. Alberta has the highest number of HPS cases to date (20 cases), followed by British Columbia (6 cases), Saskatchewan (5 cases), and Manitoba (1 case). Thus, Alberta can be considered the "hotspot" for HPS cases in Canada, with more than three times as many cases as any other province.

Figure 1-1. The cumulative number of Hantavirus pulmonary syndrome (HPS) cases in Canada, between 1989 and 1999



(References: Alberta Health, 2000; Drebot et al., 2000)

The mortality rate for the HPS cases in Canada is 38 percent (12/32). Of this total number of fatal cases, half have occurred in Alberta. The average age of HPS cases in Canada is 39 years with a range of 15 to 62 years. Sixty percent of the cases were male (19/32), and 40 percent female (13/32).

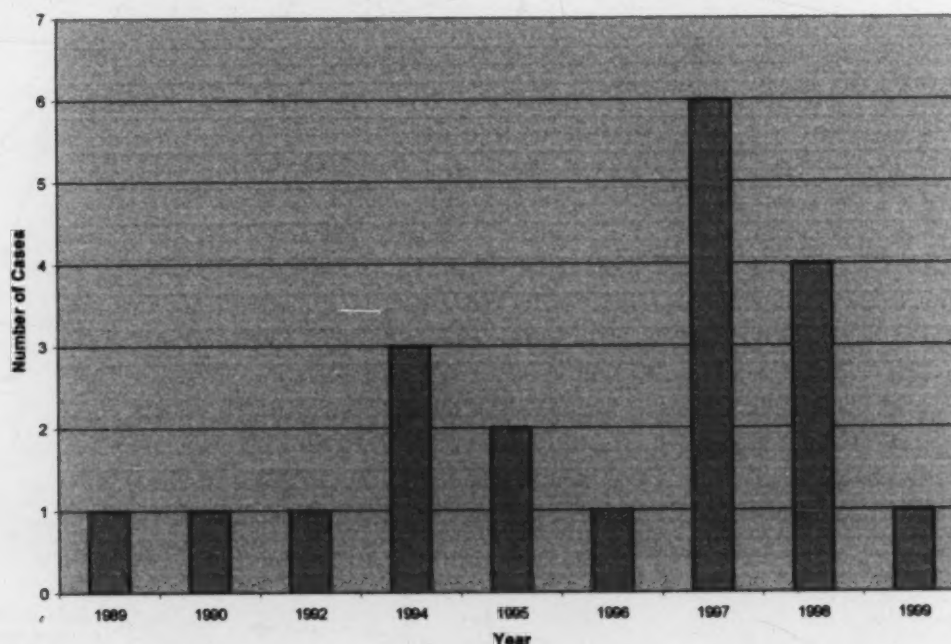
Although there are more cases in the United States, the mortality rate, male/female ratio, and age range are similar. There have been a number of cases of HPS identified since

the 1993 outbreak (May 1993) in the Four Corners Region of the United States. As of February 23, 2001, 281 cases of HPS have been reported from 31 states. The mortality rate of these cases is 38 percent. That is, 84 cases have resulted in death between May of 1993 and February 23, 2001. Most have been from the western half of the country, with some occurring in the eastern states as well. About three-quarters of the HPS cases were residents of rural areas. The age of confirmed cases ranged from 10 to 75 years, with a mean age of 37 years. The gender ratio is 60:40 male to female (CDC, 2000).

B. HPS in Alberta

The annual numbers of HPS cases in Alberta between 1989 and 1999 are documented in Figure 1-2. The highest number of cases occurred in 1997.

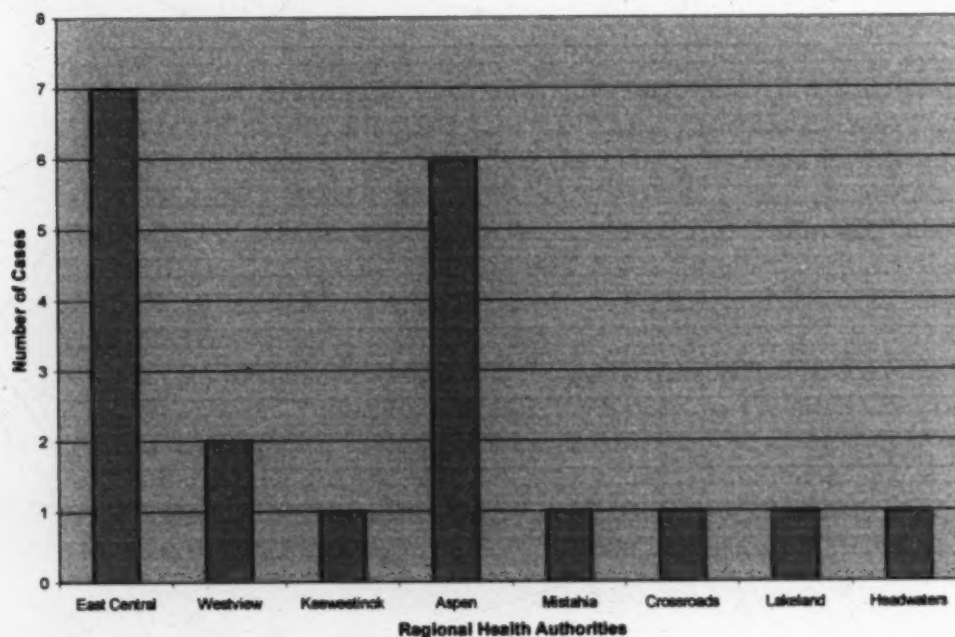
Figure 1-2. The annual number of HPS cases in Alberta between 1989 to 1999.



(References: Alberta Health, 1998a; Alberta Health, 1998b; Alberta Health, 1998c; Alberta Health, 2000).

HPS cases generally tend to occur among people in rural areas of Alberta. Most of the cases have occurred in northern Alberta with only one occurring in southern Alberta (Alberta Health, 1998c; Health Canada, 1996). The Regional Health Authorities (RHA) in which cases have occurred are East Central, Crossroads, Westview, Aspen, Keeweenaw, Mistahia, and Lakeland. The one southern case occurred in the Headwaters Regional Health Authority. Figure 1-3 illustrates the frequency of cases that occurred in Alberta between 1989 and 1999, in each of these RHAs. The greatest numbers of cases have occurred in the East Central and Aspen Regional Health Authorities with a total of 7 and 6 cases, respectively. Refer to Figure 1-4, which illustrates the location of each of the Regional Health Authorities.

Figure 1-3. The distribution and frequency of HPS cases in Alberta's Regional Health Authorities, between 1989 and 1999.



(Reference: Alberta Health, 2000).

The Regional Health Authorities (RHAs) that would fall into the boreal forest area include the Northwestern Health Services, Northern Lights, Keeweenaw, Peace, Mistahia, Aspen, Lakeland, and the Westview Regional Health Authorities. Among these RHAs, cases of HPS have been found in the Aspen, Keeweenaw, Mistahia, Westview and Lakeland regions, contributing 11 out of 20 cases in Alberta as of September, 1999.

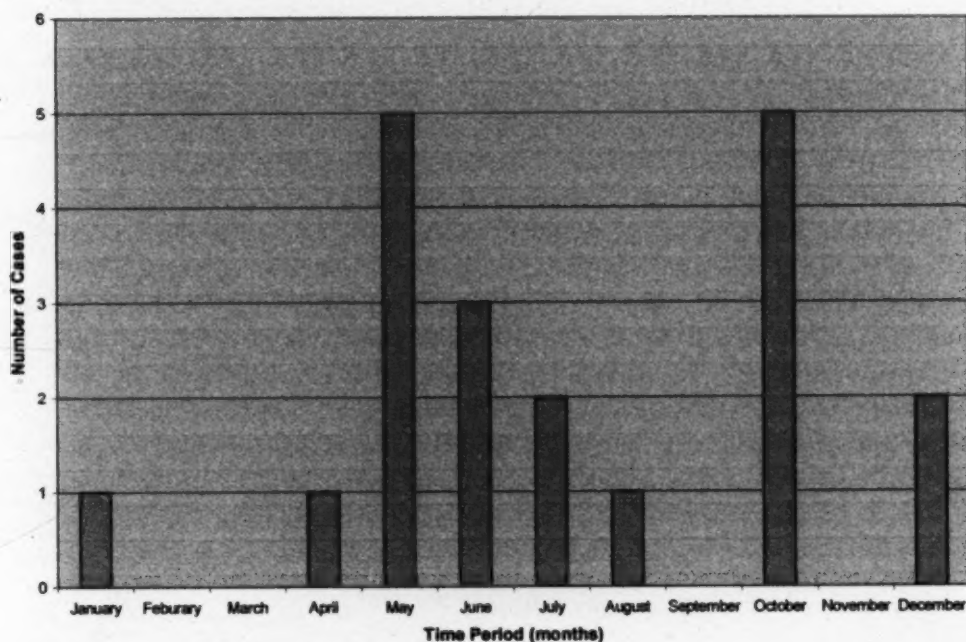
Figure 1-4. The Regional Health Authorities in Alberta.



(Source: Alberta Health and Wellness, 2001)

Figure 1-5 illustrates the times of the year when cases in Alberta occurred. Hantavirus cases have occurred more often in May and October than any other months of the year.

Figure 1-5. The number of cases of HPS in Alberta in relationship to month.



(References: Alberta Health, 1998a; Alberta Health, 1998b; Alberta Health 1998c; Alberta Health, 2000; Werker et al., 1998).

This information is important as it provides knowledge of the times of year that people may be more likely exposed or come in contact with deer mice. Activities that people may be undertaking at this time of year can then be identified. This information can facilitate advising people on the times of year they should be more concerned about taking precautionary measures.

Recommended Preventive Measures

A number of preventive measures have been documented as a strategy for minimising the risk of contact with deer mice and their excreta.

Members of the genus *Hantavirus* have similar morphologic features. Virus particles are 70 to 120 nm (or 0.070 to 0.120 microns) in diameter and generally appear spherical to oval (Goldsmith et al., 1995). It is important to know the morphological characteristics of the infectious agent so that appropriate protective equipment, such as respiratory protection, can be determined for those who may potentially come in contact with the virus. The NIOSH (National Institute for Occupational Safety and Health) filter classification that is designed to protect against dusts, fumes, and mists less than 5 microns is the HEPA (high efficiency particulate air) filter (Plog et al., 1996). However, recently there have been changes to the nomenclature for the types of filters used in the respirators. As a result, the HEPA designation has been discontinued and the current equivalents to the HEPA designation are the N-100 (not resistant to oil), R-100 (resistant to oil), and P-100 (oil proof) filters. These three filters are 99.97% equivalent to the previous HEPA filter. The N-100, R-100 and P-100 provide the same protection as the HEPA filter and, therefore, are the most effective in removing viral particles less than 5 microns. However, due to the nature of the virus, no studies have been able to test the efficacy of either the HEPA, N-100, R-100, or P-100 filters in protecting against HPS transmission (CDC, 2000).

Other protective gear includes gloves, goggles, boots, and coveralls. Hantaviruses have lipid envelopes that are susceptible to most disinfectants such as bleach (dilute hypochlorite), detergents, 70% ethyl alcohol, or most household cleaners. It is suggested people wet down a deer mouse infested area with a disinfectant, before cleaning it up. Sealing an area to keep mice out; removing mice by using poisons or traps; removing garbage; and keeping food stored away securely have been other recommendations for prevention (Chisolm, 1997).

CONCLUSION

Emerging infectious diseases such as Hantavirus Pulmonary Syndrome (HPS) suggest that factors on a micro and/or macro level play an important role in identifying and controlling these diseases. From a public health perspective it is not only important but also necessary to understand various aspects of the micro and macro level determinants of health for an infectious disease, so that mechanisms can be implemented to prevent and control these diseases. Thus, understanding factors that may have contributed to the emergence of HPS, how it is transmitted, and the clinical diagnosis of this disease contributes to the understanding of infectious disease prevention. This chapter was intended to provide an overview of hantavirus so that it may be understood in the context of this study and its findings.

CHAPTER 2: RATIONALE FOR UNDERTAKING THIS STUDY

INTRODUCTION

This chapter describes the purpose of this research study and identifies its objectives. An overview of the current research on Hantavirus Pulmonary Syndrome is provided. This information, including the discussions in Chapter one, provides the rationale behind undertaking this research study.

PURPOSE

The purpose of this research study was to determine ways of reducing the risk of exposure to hantavirus for farmers and forest professionals working in Alberta's boreal forests.

This was achieved by identifying farmers' and forest professionals' knowledge of hantavirus, personal exposures, use of preventive measures, and perceptions of risk. The information gathered was used to construct a theory to identify reasons why farmers and forest professionals may or may not be taking precautionary measures to reduce their risk of exposure to hantavirus. This process was used to identify recommendations or ways for reducing their risk of exposure.

OBJECTIVES

1. To identify the types of hantavirus information available; and understand farmers' and forest professionals' knowledge and sources of hantavirus information such as exposure, transmission of the disease, and precautionary measures.
2. To understand and document the personal exposures of forest professionals and farmers working in Alberta's boreal forest.
3. To explore farmers' and forest professionals' experiences with using precautionary measures to understand the appropriateness and applicability of these measures.
4. To identify farmers' and forest professionals' perceptions of risk related to hantavirus.

5. To construct a theory using the grounded theory method, which will provide insight into reducing the risk of exposure to hantavirus, based on their perceptions of risk.

EPIDEMIOLOGY OF INFECTIOUS DISEASES

Understanding some of the basic concepts of infectious disease epidemiology aids in understanding the factors contributing to HPS cases and ways exposure may be reduced.

Infectious disease epidemiology is characterised by the presence of at least one other active participant in addition to the human population, namely the infectious agent or parasite (Halloran, 1998); in this case it is the Sin Nombre virus (SNV). This other active participant is necessary so that the infectious agent is able to propagate and sustain itself in the environment. For such an interaction to take place, the host must be susceptible. Thus, a fundamental parameter of infectious disease epidemiology is the transmission probability. This is the probability that given contact between an infective source (in this case, the deer mouse) and a susceptible host (a person), transfer of the infectious agent can occur, infecting the host. The transmission probability depends on characteristics of the infectious source, the parasite, the susceptible host, the mode of transmission and the type and definition of contact (Halloran, 1998). The mode of transmission of a parasite determines what types of contact are potentially infectious. The type and definition of contact are related to exposure to the infectious agent. Exposure to infection is necessary for the infection and disease to occur.

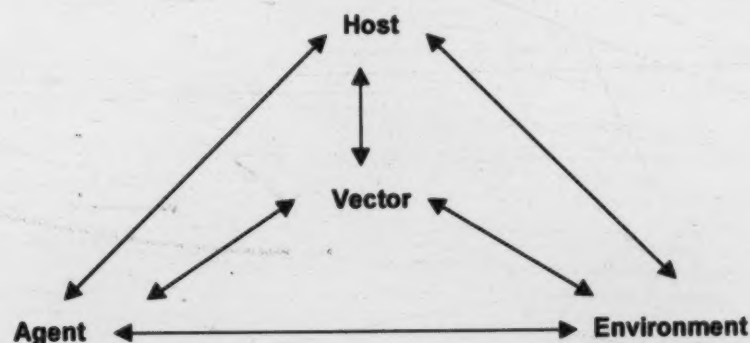
Transmission from one host to another is fundamental to the survival strategy of the infectious agent, since any host will eventually either clear the infection or die, even if from an unrelated cause. Thus, the presence of a population that will allow the virus to continue to survive is an important component of infectious disease epidemiology. Airborne transmission, the method by which the Sin Nombre virus is spread to humans, is said to be indirect transmission. In most airborne infections the individual has to be relatively close to the source to become exposed (Halloran, 1998).

Contact patterns in a population are crucial in determining patterns and exposure to infection. The concept of contact is very broad and must be defined in each particular study. In general, human susceptibility to an infectious disease can be determined by a variety of factors. From an epidemiological perspective, understanding how individuals in populations make contacts is one aspect of determining susceptibility to an infectious disease. This could include the density of the vector population; in this case it is deer mice populations. The assumption is that the larger the vector population, the greater chance the disease will spread, increasing the virus propagation, and the greater the chance of a human coming in contact with a deer mouse (Halloran, 1998).

The epidemiological disease triad shows the interaction of the host (a person), the agent (e.g. Sin Nombre virus), and the environment (e.g. contaminated air) in the transmission of the disease. The disease outcome, Hantavirus Pulmonary Syndrome (HPS), is a product of an interaction of the human host, an infectious or other type of agent (Sin Nombre virus), and the environment that promotes the exposure (such as enclosed spaces and handling of deer mice and their excreta). A vector, the deer mouse, is involved in transmitting the Sin Nombre virus to humans.

The following figure (Figure 2-1) shows in an epidemiologic disease triad how each of these components may interact with each other:

Figure 2-1. The epidemiologic triad of a disease (Gordis, 1996).



CURRENT RESEARCH ON HANTAVIRUS PULMONARY SYNDROME (HPS)

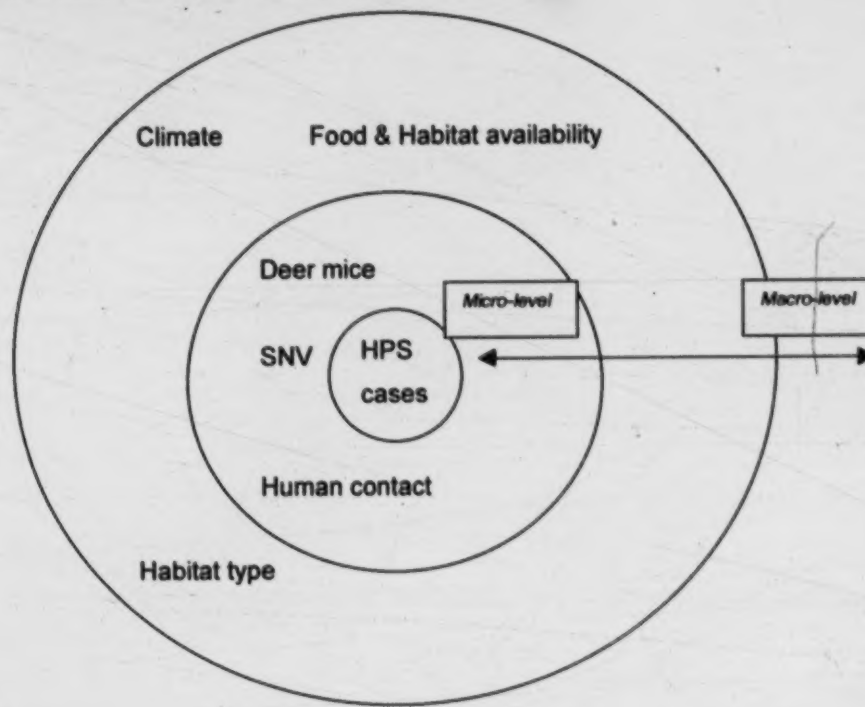
Understanding the ecology of the agent of disease and its interaction within its environment (ecosystem) is necessary if effective means are to be deployed in controlling and preventing such diseases. Ecology is essentially the scientific study of the relationship between organisms and their environments.

Adopting an ecological approach to understanding and predicting the emergence of infectious diseases such as HPS, means viewing the basic components and functions of ecosystems in a broad context, integrating environmental, social, political and economic concerns. It recognises that the progress of human societies and economies does not take place apart or separate from the environment (Economic Commission for Europe, 1993; CCME, 1996).

Some factors that would affect the ecological approach in relationship to HPS are the ecology of the virus, which includes such factors as habitat and habitat quality and availability of food; the ecology of deer mice; density of deer mice populations; climate; occupational exposure; and the use of preventive measures. This ecological approach can provide valuable insights into the emergence of diseases and its potential effect on human populations.

A variety of factors have been identified as contributing to Hantavirus Pulmonary Syndrome cases. Current HPS research has focused on climate, food and habitat availability, habitat type, habitat change, deer mice, SNV, human contact and HPS cases (Figure.2-2).

Figure 2-2. Macro and micro continuum of focus on HPS.



The following sections summarise the discussions of the micro and macro levels of factors influencing HPS cases.

Understanding the Ecology of an Infectious Disease

This component describes the transmission of the Sin Nombre virus to deer mice, the rodent reservoir; the ecology of deer mice, which facilitates understanding how humans may come in contact with deer mice; and the transmission of the Sin Nombre virus from deer mice to humans.

A. The Ecology of Deer Mice

The geographic distribution of the deer mouse defines the maximum area in which the disease, hantavirus pulmonary syndrome, can be endemic (Mills & Childs, 1998). The deer mouse (*Peromyscus maniculatus*) is the primary known carrier of the Sin Nombre

virus that causes HPS in Canada. This particular rodent species is commonly found throughout Canada (Whitaker, 1980).

The deer mouse, often described as a "quintessential generalist," can survive on any dry land habitat in its range and invade and exploit areas disturbed by flood, avalanche, landslides, mining construction, extreme grazing, or land development. In ecologically stable areas, deer mice may be limited by the presence of more specialised rodent species (Fitzgerald, Meaney, & Armstrong, 1994). However, they can also be found from forests to grasslands, canyons to deserts, farmlands to farmhouses and suburban homes, moving into the latter more often in fall but able to take up residence wherever an opportunity presents itself. Deer mice are more common on sparsely vegetated sites and areas of open soil surface, which may be related to their consumption of seeds (Kaufman et al., 1988). Thus, the movement of SNV-infected deer mice into human residences itself creates a risk factor for HPS (Calisher et al., 1999). They may enter areas of human habitation, particularly under circumstances of high rodent density (Pan American Health Organisation, 1999). In addition, the level of physical contact between mice is proportional to the availability of limiting resources (Vessey, 1987), which is another risk factor for HPS.

Although deer mice can be found in a number of habitats, the prevalence of SNV infection varies among habitat types, being lowest at the climatic and altitudinal extremes (e.g. desert or alpine tundra) and highest in middle-altitude habitats (e.g. woodlands) (Mills & Childs, 1998). They feed on various foods, including seeds and nuts, small fruits and berries, insects, centipedes, and the subterranean fungus. In the prairies the food primarily consists of the seeds of foxtail grass, wheat, caterpillars, and corn. Deer mice are common in cultivating situations and remain even during harvesting and plowing periods. Although seeds form a large portion of the deer mouse diet, terrestrial arthropods can also be important in their diet (Graves et al., 1988; Koehler & Anderson, 1991). They dig small burrows in the ground, or nests in raised areas, in woodlands they are common in hollow logs (Whitaker, 1980).

Understanding the ecology of deer mice can provide some insight into where they may be found and their general behaviour. This has implications for identifying where humans may come in contact with deer mice, and potentially SNV.

B. Prevalence of the Sin Nombre Virus in Deer Mice Populations

The distribution of the host and pathogen among different biotic communities and habitat types indicates the risk for human infection in various habitats within a geographic region. The extent of the geographical area in which the infected host can be found indicates the area in which human disease can be endemic. SNV infection has been found in deer mice throughout North America north of Mexico, with the exception of Alaska (Mills et al., 1998; Drebot et al., 1997). The geographic range of infection by the pathogen within reservoir populations may be dynamic, not static (Mills & Childs, 1998). Prevalence of infection in reservoir populations may be very high in some localities and very low, or absent, at nearby sites (Mills et al., 1997; Glass et al., 1998). It is likely that pathogens periodically become extinct in local reservoir populations. The dynamics and factors controlling these processes are unknown but indicate that, although a single cross-sectional survey approximates the range of infection, repeated surveys or longitudinal studies are necessary to elucidate temporal and spatial patterns (Mills & Childs, 1998). Even when the incidence of human disease is extremely low, reservoir surveillance provides a clearer definition of potential disease endemic areas than human disease surveillance, especially in HPS-endemic areas (Mills & Childs, 1998).

The rapid turnover of the rodent populations (as older antibody-carrying mice die and non-immune mice are born), causes antibody prevalence of the virus in deer mice populations to vary greatly, from 0% to 50%, with prevalence generally lower than 20% (Shope, 1999).

Although only the western Canadian provinces have reported cases of HPS, the virus is distributed across Canada in the rodent reservoir (Werker et al., 1998). Health Canada's LCDC conducted a hantavirus surveillance in Canada between 1995 and 1996. Of the approximately 5,000 deer mice tested for the Sin Nombre virus, seropositive mice have been identified in eight provinces and the Yukon. Alberta appeared to have the most widespread prevalence of seropositive mice. The seroprevalence of the Sin Nombre antibodies in deer mice trapped in British Columbia ranged from 3.4 percent to 20.8 percent and in Alberta from 1.2 percent to 42.0 percent (Health Canada, 1996). However, in Ontario, Quebec and New Brunswick, infected deer mice were found with a variant of Sin Nombre virus (Werker et al., 1998). In addition to having three times as

many cases of HPS compared to B.C, Alberta also has a higher rate of seroprevalence of the virus in the deer mice.

Identifying the prevalence of the Sin Nombre virus within deer mice populations can provide a more precise understanding of where the disease is prevalent. It may also provide some insight into how the disease is transmitted in deer mice populations. These factors have implications for reducing human exposure.

C. Transmission of SNV to deer mice

Since the 1993 outbreak in the southwestern United States, at least 20 additional hantaviruses have been isolated from rodents throughout the Americas; about half are known human pathogens (Mills & Childs, 1998). However, currently in Canada only one hantavirus serotype has been identified; the Sin Nombre Virus (SNV).

SNV is shed in the saliva, urine, and feces of deer mice. Infected mice do not display any obvious symptoms of disease and can become persistently infected with chronic shedding of the virus for weeks to years. Whether deer mice are infected at birth or not has been unclear. However, present studies suggest that rodents are not infected with the Sin Nombre virus at birth, but rather they acquire the virus from other rodents (Shope, 1999). Once infected they develop antibodies, and many if not all infected rodents remain infected. Deer mice infected with SNV when very young could serve as virus reservoirs for the remainder of their lives. Their average life span may not be much more than a few months. However, some deer mice live for 1 to 2 years, and some longer, providing a trans-seasonal mechanism for virus persistence (Calisher et al., 1999). In addition, the assumption is that the longer a deer mouse lives the greater its probability of becoming infected with SNV. Infected rodents serve as subsequent sources of infection for others in the population (Calisher et al., 1999).

The precise mechanism(s) of transmission of SNV in rodents is not known but could include horizontal transmission through biting, cross-grooming, breeding behaviour, or inhalation of the virus shed in the excreta (Biggs et al., 2000).

Some studies suggest that contamination of wounds when animals fight may be an important route of infection between rodents, while allowing for the possibility of

secondary mechanisms, such as venereal transmission or close association during communal nesting (Shope, 1999).

Fighting and biting among adult male rodents may be a mechanism for transmission of this virus. Scars or wounds on rodents can indicate intraspecific aggressive encounters. Calisher et al. (1999) conducted longitudinal studies in montane and semi-desert shrubland to monitor SNV dynamics in natural rodent communities. They found a positive association between wounds and SNV antibody in adult rodents, predominantly deer mice, suggesting that when infected rodents fight with uninfected rodents, virus amplification occurs (Glass et al., 1988).

In North America the prevalence of antibody to SNV among male deer mice is at least twice that among females (Mills et al., 1997), and scarring appears associated with the presence of antibodies (Mills & Childs, 1998). A study done by Calisher et al. (1999) found that male rodents comprised a larger percentage of seropositive mice, which suggests that males contribute more to the SNV epizootic cycle than female mice. Another study done by Kuenzi et al. (1999) found that antibody-positive rodents were more likely to be adult male than female.

Another suggested mechanism of virus transmission depends on short-term infections of deer mice infected as sub-adults or as adults. At periods of population peaks (e.g. at the end of the breeding season, in late summer and fall, and during period of decreased availability of food), male mice fight one another for breeding partners, food, and territory (Calisher et al., 1999).

Other studies have suggested potential mechanisms of SNV transmission within deer mice populations are related to the relative frequency of infection in different demographic subgroups (sub-populations). An association of antibody prevalence with age, suggesting horizontal (rather than vertical) transmission, has been documented for deer mice (Mills et al., 1997). This species exhibits a J-shaped curve of antibody prevalence with age; very young animals had prevalence similar to some adults. This pattern could be explained by the presence of maternal antibody in the offspring of infected females; as this apparently protective antibody wanes, animals become infected (Mills & Childs, 1998).

Further study of these mechanisms may lead to an understanding of the timing and conditions under which increased transmission in reservoir populations takes place, which could lead to improved prediction of how and when humans become infected (Mills & Childs, 1998).

D. Transmission of SNV to Humans

Transmission to humans is primarily airborne by humans inhaling aerosolised droplets of urine and particulates contaminated with rodent excreta. In a very small number of cases infection has been reported after rodent bites (Fink, 1996). Person-to-person transmission of HPS has not been documented in North America despite extensive epidemiological studies (Chisolm, 1997; Pflieger & Khan, 1997; Hallin, et al., 1996; McKee, et al., 1991). However, there have been incidences documented in Southern Argentina (Chisolm, 1997; Wells et al., 1997).

Activities that increase the risk of exposure to deer mice

Factors of the host-virus interaction (time course of infection and periods of maximum virus shedding); rodent behaviour (entering human habitations); and human behaviour (planting/harvesting in the spring/fall and opening and cleaning rodent-infested sheds or cabins in the spring), interact to modify temporal risk of contact or exposure patterns (Mills et al., 1999). A case-control study done by Crowcroft et al. (1999) found that cases of HPS were more likely to have entered a building where there were rodents, and were more likely to have been cleaning and raising dust.

Hantavirus may affect those individuals who come in frequent contact with deer mice feces and urine, especially in closed structures (such as seasonally abandoned cabins or barns), and places where mice may nest (such as hay bails, barns or in and around homes). They also may come in contact with deer mice by inhabiting or cleaning rodent-infested dwellings (Xu et al., 1985; Zeitz et al., 1995). Often these individuals have exceptionally close exposure with deer mice (Alberta Health, 1998c). However, according to Jay et al. (1996), activities that place persons at an increased risk for exposure to HPS have not yet been well characterised.

Khan et al. (1996) identified some of the data available on rodent exposure for these 100 cases of HPS in the United States. They found that 48 cases (48%) had rodent exposures closely associated with peridomestic activities in areas that showed signs of rodent infestation. There were 12 cases (17%) that had combined occupational and peridomestic exposure to rodents, 3(4%) had documented occupational exposure (agricultural extension worker, graduate biology student, and mammalogist), and 6 (9%) had a recreational or combined peridomestic-recreational exposure, such as camping. The majority of HPS patients have had clearly identifiable peridomestic, recreational, or occupational exposure to rodents (Khan et al., 1996).

In Canada, activities and occupations associated with HPS cases were identified as follows: domestic (34.3%), farm (25.0%), domestic and additional risk factors (15.6%), lumber mill (3.1%), military (3.1%), ranch (3.1%), recreational activities (3.1%), and wildlife surveys (3.1%). In addition, in 9.4 percent of the cases the exposure was unknown (Drebot et al., 2000). Of the 20 HPS cases reported in Alberta, 65 percent (13/20) were likely exposed during occupational activities. Farming was most common (10/20). All cases lived and worked in rural areas. More than 40 percent of cases occurred during the months of April, May and June, coinciding with the reproductive period of the deer mice, when deer mice populations are at seasonal highs (Health Canada, 1995; Werker & Artsob, 1998; Werker et al., 1998).

Overall, farming, domestic, forestry related, biology, and recreational activities have been some of the exposures pertaining to cases of HPS in Canada and the United States. According to Fink (1996), there is probably greater incidence among those occupationally exposed (e.g. agricultural workers, hunters or trappers), with mortality/morbidity being attributed to other disease conditions.

Rodent Density and Contact

Demographic changes in reservoir host populations could mean an increased risk for viral transmission to human populations. The assumption is that the risk of human disease is directly related to reservoir population density because increased density increases the probability of human contact with infected rodents (Mills & Child, 1998).

The highest risk for human contact with infected rodents is then assumed to be during the period of highest rodent population density.

In some studies, increases in reservoir populations have been associated with increased numbers of HPS cases in the southwestern United States (Mills et al., 1999). Anecdotal reports by local residents in the 1993 hantavirus outbreak area (the Four Corners region of the U.S) also identified that there had been a large increase in the rodent population just prior to the first cases being reported. Studies of rodent populations in central New Mexico at the time of the outbreaks also documented an increase in *Peromyscus* populations (Parameter & Vigil, 1993). Outbreaks of hantavirus disease were also associated with increases in rodent populations in Europe and Asia (Xu et al., 1985; and Yanagihara, 1984).

Although human infection may be associated with an increase in rodent populations, there is still a great deal of uncertainty with studies assessing the correlation between rodent density and seroprevalence in deer mice. Some studies have shown that an increase in deer mice population densities are proportionally related to an increase in the prevalence of the Sin Nombre virus within those mice populations (Parmenter et al., 1993). However, other studies have found that either there is no relationship between an increase in deer mice population and seroprevalence in mice, or a reverse effect, that is a decrease in deer mice populations and an increase in mice seroprevalence. Although Kuenzi et al. (1999) suggests a correlation between population size and prevalence of hantavirus antibody, they acknowledge that their sample size was too small to determine a statistical significance. Other studies in the Channel Islands (Graham & Chomel, 1997), Montana (Douglass et al., 1996), and the regional study of Mills et al. (1997), found no relationship between antibody prevalence and density of deer mice. Graham & Chomel (1997) found that the lowest prevalence occurred in the densest population, and the highest prevalence, found in the same population, occurred at a density similar to that of other locations. Their results indicate that perhaps infection rates may be independent of mouse population dynamics.

Monitoring mouse population size may not be an effective predictor of infection, but it may still be the best monitoring tool, because it indicates the likelihood of exposure to

deer mice and their feces and urine and thus the potential risk for SNV (Graham & Chomel, 1997).

The Effects of Macro-level Factors on Hantavirus Pulmonary Syndrome

Reservoir population density is influenced by characteristics of the biotic environment (e.g. food supply and habitat quality), which is influenced by the physical environment (e.g. climate, weather, and edaphic conditions) (Mills & Childs, 1998). Habitat quality and climate have been some of the macro-level factors that have been studied in relation to hantavirus pulmonary syndrome.

A. Habitat Quality: Food and Habitat availability

Although a strong correlation between rodent density and seroprevalence has not been observed, frequencies of encounters, and therefore physical contact, between individual rodents may be dependent upon the interaction on rodent density and certain habitat related variables, including food availability and plant cover (Biggs et al., 2000). In addition, according to Langlois (1996), ecoregions are important to study because landscape composition may be a more important predictor of rodent seroprevalence for SNV than such factors as season, viral strain, climate, buildings, or association with human disease.

Biggs et al. (2000) evaluated densities of deer mice, plant cover and biomass, and terrestrial arthropod biomass to identify factors that may affect the seroprevalence rate of SNV within mice populations, in a five-year study. Their study found that in areas with lower level of understory plant cover there were higher densities of deer mice and a higher arthropod biomass. The assumption then is that a higher biomass of arthropods may increase food availability and therefore contribute to higher deer mice densities. Their study demonstrated a significant interaction between SNV seroprevalence and deer mice density, which is contrary to some recent studies (Graham & Chomel, 1997; Mills et al., 1997; Otteson et al., 1996). The study done by Biggs et al. (2000) indicated that when arthropod biomass was relatively high, seroprevalence was low, and that when arthropod biomass was low, seroprevalence was high. These results support the idea that when food availability is low, animals competing for limited resources are more

frequently in physical contact and therefore are more likely to spread SNV throughout the population (Abbott et al., 1999). Thus, the data from the Biggs et al. (2000) study indicate that rodent density may be the primary driver for seroprevalence but also suggest that food availability may contribute to the seroprevalence within a rodent population.

Seroprevalence of the Sin Nombre virus in populations of *Peromyscus* varied as a function of habitat and population density. Data from Abbott et al. (1999) demonstrate that distinct "islands" of hantavirus infection are apparently associated with preferred microhabitat. Characterizing preferred habitat types might help identify areas at increased risk for virus transmission to humans. However, these pockets of reservoir activity become blurred during periods of high reservoir population density (Abbott et al., 1999). Perhaps during rodent population irruptions, there might be increased movement of individual rodents away from the preferred habitat to find habitats with less competition for food and territory. This may lead to transfer of virus among previously distinct sub-populations, thereby increasing the overall risk for human exposure (Mills et al., 1999).

B. Climate

Changes in climate and the environment have many direct and indirect effects on human health (Leaf, 1989; Chivian et al., 1993; McMichael, 1998). Extreme climatic events, such as droughts and floods, are expected to increase with predicted global climate changes. Many disease outbreaks, such as hantavirus epidemics, have occurred after extreme climatic conditions (Wilson, 1995).

Climate changes or weather may influence the emergence of infectious diseases, for example the 1993 US HPS outbreak. SNV may have been endemic to the deer mouse population and a weather anomaly caused by a large scale climatic phenomenon may have lead to an increase in the mouse population and a subsequent increase in the transmission probability (Levins et al., 1993). The same cause may have been responsible for outbreaks of hantaviral disease in Europe at approximately the same time (Le Guenno et al., 1994; Rollin et. al., 1994).

The prolonged El Nino Southern Oscillation (ENSO) event of the early 1990s may have potentiated the unexpected outbreak of HPS, in the southwestern United States (Duchin et al., 1994). ENSO is a cyclically recurring disruption of the oceanic/atmospheric system in the tropical Pacific. The ENSO phenomenon has important consequences for weather around the globe, including increased rainfall across the southern regions of the United States as well as parts of Central/South America (CDC, 2000). In the early 1990s, the climate of the southwestern USA was unusually dry, causing widespread changes in animal populations. Some predator species (snakes and birds) declined; therefore, their prey species (virus carrying mice) populations sharply increased. Subsequently the ENSO-associated heavy rains of 1993 lead to a local greening, including a profusion of pine nuts and grasshoppers that fuelled a proliferation of mice. This in turn led to a rise in deer mouse populations, increasing human-rodent contact in the spring and dry summer months of 1993 when the outbreaks occurred in the Four Corners region (McMichael, 1998). Because the 1992 to 1993 El Nino resulted in an abundance of rodent food resources and a twenty-fold rodent population increase over the previous year, increased rainfall from El Nino was associated with the 1993 HPS outbreak (Parmenter et al., 1993). A similar pattern of above average rainfall followed by drought was observed preceding an outbreak of HPS in western Paraguay in 1995 to 1996 (Williams et al., 1997).

Available evidence suggests that dramatic increases occurred in rodent populations in the Southwest during 1991-1993. When the ENSO phenomenon first began to occur during the summer of 1991, the population densities of deer mice in New Mexico increased from less than one deer mouse per hectare to over five per hectare in eight months. Continuing ENSO conditions led to a second mild winter and abundant moisture, so that by the spring of 1993 there were 20 to 30 rodents per hectare. It was during this period that the well-known outbreak of HPS occurred (CDC, 2000). This increase in rodent population led to a change in the virus/host dynamic. Field studies suggest that hantaviruses may be transmitted among rodents through encounters between adult rodents (perhaps when an infected rodent bites an uninfected rodent). As population density increases, rodents are more likely to encounter each other, resulting in virus-transmission events. This pattern may have happened prior to the HPS outbreak in the Four-Corners area. The prevalence of hantavirus infection among deer mouse populations in the outbreak area in 1993 was as high as 30 percent. When rodent

density is higher, the chance of encounters between rodents and humans is also greater, because the chance that rodents are going to encounter and enter rural homes is greater (CDC, 2000).

Preventive Measures

Some research has also been conducted in the area of preventive measures for hantavirus pulmonary syndrome. An oral traditional study was done in association with the Centers for Disease Control (CDC) shortly after the 1993 Hantavirus Pulmonary Syndrome (HPS) outbreak. Navajo elders were interviewed, and they stated that in Navajo medical traditions, mice were considered to be bearers of an ancient illness that even predates the bubonic plague in the Navajo region. Therefore, traditional medicine suggested avoiding mice, and isolating food supplies. In addition, oral traditional information said that in 1918 and 1933-34, there were similar outbreaks, after increases in rainfall produced increases in the pinon crop and the number of mice (Centres for Disease Control, 1997).

A study done in the Four Corners region of the United States examined the occupational exposure risk of workers to hantavirus and the extent of their knowledge of HPS, of measures used to protect against HPS, and their actual use of those measures. Of the 451 workers surveyed, 80 percent indicated that they had received some type of instruction about the prevention of HPS, 29 percent indicated that they were highly knowledgeable about HPS. In addition, 85 percent believed that HPS is an extremely serious disease and nearly 12 percent believed that they were at "high" risk of HPS. Greater than 80 percent of respondents felt that standard protective measures would reduce their risk, but far fewer workers actually used the protective measures. There was no association between a perceived "high" risk or "high" rodent contact and the use of any of the protective measures. However, there was a strong association between high knowledge of hantavirus and use of protective measures (Miller et al., 1998).

In October of 1994, an information line was put in place by the Edmonton Board of Health to address public concern related to Hantavirus Pulmonary Syndrome and disseminate information on hantavirus. The Board of Health and other health agencies also provided information to the public on risk reduction through the news media

updated daily through interviews and/or press releases. Six months later a telephone survey was carried out to assess the effectiveness of this recorded information line and the accuracy of recall information. Of those surveyed, 68 percent recalled hearing about hantavirus; 58 percent said they knew what hantavirus was; and when asked to define it, 93 percent did so accurately. This confirmed that the information disseminated about hantavirus, whether through the information line, media (television, newspaper, and radio) or other sources (word of mouth, or work), was correctly understood. However, in terms of the effectiveness of this information only 30 percent of the respondents took action to clean up mouse droppings or otherwise prevent themselves from coming into contact with mice or their droppings (Predy et al., 1997). Thus, the majority of individuals surveyed did not take preventive action.

Preventive measures have been suggested, but there has not been an exploration on the efficacy of this information, or whether these measures are in fact useful and/or appropriate for these individuals.

RATIONALE FOR UNDERTAKING THIS STUDY

Chapters one and two have provided extensive information on Hantavirus Pulmonary Syndrome and some of the current research that has been done in this area. Previous HPS studies have focused on aspects of deer mice density as they relate to prevalence of the SNV in deer mice and contact with humans, transmission methods of the virus to deer mice and then to humans, exposure studies, prevention studies, and macro-level factors such as habitat quality and climate. All of these components are important in understanding HPS in an ecological framework, with each facet contributing to the knowledge on reducing HPS cases and predicting potential outbreaks of cases. This information also provides evidence for the rationale in conducting this study.

This research study focuses on the prevention aspect of Hantavirus Pulmonary Syndrome in Alberta's boreal forest. Although HPS is a rare disease in Canada it has a high mortality rate of approximately 33 percent. Alberta has the highest number of HPS cases in Canada: 20 out of the 32 cases. Half of the cases that were fatal in Canada occur in Alberta: 6 out of 12. In addition, just over half of the HPS cases in Alberta occur in the regional health authorities that fall within the boreal forest ecoregion: 11 out of 20.

Exposures to the virus are high for occupational groups such as agricultural workers, forest workers, and other industrial workers. In addition, a large proportion of cases associated with HPS in Alberta was from occupationally related activities.

For those who may potentially be exposed to deer mice and their excreta, we can not predict or observe which deer mice may be infected with the Sin Nombre virus; prevention is a key in reducing one's risk of exposure. Zeitz et al., (1997) concluded that because we cannot predict which rodents are SNV infected during occupational exposure, an increased understanding of hantavirus transmission to humans will help focus future recommendations to more effectively maximise human protection. Studies have attempted to ascertain the sources of hantavirus awareness of general information as well as how to prevent it. Only a few have asked whether these individuals practice or use the suggested prevention methods. There are many sources addressing issues of hantavirus and hantavirus prevention. However, little is known about the usefulness of this information and individual's perception of hantavirus risk in Alberta. This research project will address these issues and propose some recommendations for preventive action.

CONCLUSION

This chapter reviewed the existing knowledge on hantavirus in the literature and identified the rationale for conducting this research study.

CHAPTER 3: METHODS

INTRODUCTION

The purpose of this chapter is to describe and justify the research methods used in undertaking this study. First an overview of the grounded theory research method is provided. Then a more detailed description of the data collection process and analysis is discussed. Finally, methods of assessing trustworthiness of this research are described.

OVERVIEW OF THE THEORETICAL FRAMEWORKS USED IN THIS STUDY

There were three theoretical frameworks used at various stages of this project: grounded theory, risk perception, and the health belief model. The following sections describe each theoretical framework and how it was used within this study.

Grounded Theory: A qualitative method

Qualitative and quantitative research methods contribute differently and at different stages of the knowledge-building enterprise. A qualitative method was chosen to explore various hantavirus issues with farmers and forest professionals in Alberta. This is an appropriate method to use when one's research is exploratory in nature (Tutty et al., 1996), particularly studies investigating social and human problems (Creswell, 1998); when the intent is to understand the unique experiences of individuals or groups (Patton, 1990); and when little is known about a problem, qualitative methods can provide exploratory information about possible needs and interventions (Gorman & Clayton, 1997). It is for all these reasons that a qualitative approach was chosen for this study.

More specifically, the type of qualitative research method used for this study is grounded theory. The goal or objective of grounded theory is to discover and generate theory that relates to the context of the phenomenon being studied (Chenitz & Swanson, 1986; Strauss & Corbin, 1990). This method develops theory that is "grounded" in the data; that is, the theory developed is based on categories that emerge from the data. A category represents a unit of information composed of events, happenings, and instances (Strauss & Corbin, 1990). However, simply identifying these categories does not describe the grounded theory, for it does not provide meaning to the context of the

phenomenon. For this to occur a grounded theory must consist of "plausible relationships proposed among concepts and sets of concepts" (Strauss & Corbin, 1998; p. 168). The plausibility of the theory is strengthened with continued research by adding "conceptual density" and richness in identifying and developing the relationships among and between the categories (Strauss & Corbin, 1994).

Grounded theory researchers are interested in processes or patterns of action and interaction between various types of social units (Strauss & Corbin, 1998). It has mostly been used to explain basic patterns common in social life or social phenomena, such as individuals interacting, taking actions, or engaging in a process in response to a phenomenon (Chenitz & Swanson, 1986).

Grounded theory is often used in research endeavours where very little work has been done in a particular area (Strauss & Corbin, 1990). Most of the Hantavirus Pulmonary Syndrome (HPS) research emphasis has been on the ecological and genetic aspects of deer mice and the Sin Nombre virus, as well as the physiological nature of the disease as it relates to HPS cases. However, very little research has been done exploring individual's knowledge, use of precautionary measures, and perceptions of hantavirus risk. This study uses grounded theory as a tool to uncover, explore, and describe a theoretical framework which examines farmers' and forest professionals' knowledge and exposure to hantavirus, use of precautionary measures, and perceptions of their risk related to hantavirus.

A Theoretical Description of the Grounded Theory Process

To understand the processes or patterns of actions taken by individuals or groups in response to a phenomenon, the researcher collects primarily interview data during multiple visits to the "field", develops and interrelates categories of information, and then generates theoretical relationships (Creswell, 1998). The theory itself evolves during the actual research, through a systematic process of gathering and analysing data. This occurs by continuously comparing the data collected from each interview and is often referred to as the analytical process of "constant comparative analysis" (Glaser & Strauss, 1967). Data are initially coded to reflect various dimensions of a phenomenon. Often, the words of the subjects themselves are used. Codes are then compared;

similar codes are clustered and given an initial label, thus forming a category. Further data collection and analysis will produce other categories; some will be later re-coded and some categories will be combined with others. The data are then analysed for patterns of relationships between two or more categories. These patterns of relationships form initial hypotheses to be tested in subsequent interviews (Glaser, 1978). As new categories emerge the researcher needs to understand the dimensions of these categories and their relationship to other categories. As a result, the interviews focus now on these new emerging categories until the data becomes "saturated", that is when no more new information for categories, sub-categories and their relationships emerges from the data. The relationships to other categories are essentially the conditions, strategies, and consequences that would tie one category to another. Relationships between categories continue to be developed until a pattern among them is conceptualised. Analysis now focuses on the interrelationships and a general theory about these relationships is produced. Thus, at each phase of the analysis for grounded theory, the researcher generates hypotheses about categories, their relationships and interrelationships, and tests these hypotheses with data. Therefore, the joint collection and analysis of data are an essential strategy of grounded theory research (Chenitz & Swanson, 1986).

Throughout this process the researcher seeks out participants who would be able to provide added insights to the emerging categories. This is referred to as theoretical sampling.

Risk Perception

This study examined the theoretical framework of Risk Perception to aid in constructing the interview guide questions (refer to Appendix A) which were used to probe for information from participants. These general concepts were used to initiate the grounded theory process of theory discovery and generation for this particular study. This theory was examined because it provided some insight into health behaviours and factors that contribute to an individual's motivation to take action. Although earlier critics have suggested that using existing theories to initiate grounded theory may bias the theory generating process, it is actually a point of entry to begin the discovery of new

theory. Subsequent to this starting point other concepts were allowed to emerge from the data and the process of grounded theory research was allowed to evolve.

Risk Perception theory identifies concepts that can modify our behaviour and the way we manage risk. This conceptual framework provides an enriched understanding of how people experience and assess risks. What they actually do to manage their exposure to risk depends on whether they think it threatening or whether they feel they can do something about it (Covello, 1995; Osei, Amoh, & Schandorf, 1997).

There are several elements that contribute to the understanding of risk perception and acceptability of that risk (Covello, 1995; Osei, Amoh, & Schandorf, 1997):

- a. **Voluntary and involuntary risk:** People may be more willing to accept voluntary risk than involuntary risk activities and sometimes assume they are normal conditions of existence.
- b. **Controllability and uncontrollability of risk:** People believe that once the risk is under their personal control it is of less concern to them but are more worried about those risks that they consider to be outside their control.
- c. **Familiar and unfamiliar risk:** People tend to exaggerate the risk involved in an activity that they are not accustomed to or are scientifically unknown.
- d. **Immediate and future consequence of risk:** The timing of the consequences of the risk to ill health has a substantial impact on individual perception and acceptance of the risk.
- e. **Presence of alternatives to the risky situation:** If there are no practical alternatives in sight, many adverse conditions that are very risky are accepted and considered normal and less risky.
- f. **Type and nature of risk consequence:** Whether the outcome is expected to be fatal, crippling, or merely a temporary inconvenience. Furthermore, if the consequences are seen as irreversible, the perceived risk increases.
- g. **Derived benefits from taking the risk:** People are concerned not only about the magnitude of the risk resulting from a given exposure or technology, but also about benefits.
- h. **Portrayal of risk in the media and in life:** People are extremely vulnerable to verbal and visual cues, and so the way the risk of an activity is portrayed to an individual or group of people will have great influence on their perception of the risk.

- i. **Availability of information:** Availability of information will also affect risk perception.
- j. **Personal involvement:** If the consequence does not affect him/her directly, or is not in his/her immediate vicinity, the event is perceived to be less risky.
- k. **Memory of the consequence:** As time passes and the memory of an event begins to fade, the fears are also diminished and thus the event seems less risky.
- l. **Degree of trust in regulatory authorities:** People are more likely to perceive their risk as higher if they do not trust the regulatory authorities.

Some of these elements, such as the concepts of controllability, familiarity, and availability of information were used in constructing the interview guide. Risk perception theory was used as a tool to understand the perspectives of farmers and forest professionals in terms of their occupational risks.

Health Belief Model

The Health Belief Model (HBM) is one of the most widely used conceptual frameworks in health behaviour research. It has been used both to explain change and maintenance of health behaviour and as a guiding framework for health behaviour interventions (Strecher & Rosenstock, 1997). In the HBM context, it is understood that diverse demographic, personal, structural, and social factors are capable of influencing health behaviours. However, these variables are believed to work through their effects on the individual's motivations and subjective perceptions, rather than functioning as direct causes of health action (Becker et al., 1977).

The basic components of the HBM are derived from a well-established body of psychological and behavioural theory, with models hypothesizing that behaviour depends mainly upon two variables. These variables are (1) the value placed by an individual on a particular goal and (2) the individual's estimate of the likelihood that a given action will achieve that goal. When conceptualised in the context of health-related behaviour, the correspondences were (1) the desire to avoid illness (or if ill to get well); and (2) the belief that a specific health action will prevent (or ameliorate) illness (that is the individual's estimate of the threat of illness and of the likelihood of being able, through personal action, to reduce that threat).

It is believed that individuals will take action (cues to action) to prevent, to screen for, or to control an ill-health condition if they regard themselves as susceptible to the condition (perceived susceptibility). If they believe it to have potentially serious consequences (perceived severity); if they believe that a course of action available to them would be beneficial in reducing either their susceptibility or severity of the condition (perceived benefits); or if they believe that the anticipated barriers (e.g. costs or difficulty in understanding or using prevention information) to taking action are outweighed by the benefits. In addition, an individual will take action when one has the confidence in one's ability to successfully take action (self-efficacy). This can be reinforced by such efforts as training programs, information packages, guidance in taking action, verbal reinforcement, and demonstrating or communicating desired behaviours (Strecher & Rosenstock, 1997).

Contributions of the Three Theoretical Frameworks in the Development of the Conceptual Framework

Table 3-1 outlines the ways in which grounded theory, risk perception, and the health belief model contribute to generating the conceptual framework produced in this study. During the development of the research question stage risk perception, the health belief model, and grounded theory were used. The question of interest asked about farmers' and forest professionals' perceptions of risk, as a way of understanding risk reduction for these occupational groups. A specific question was not asked because grounded theory was going to be used as the data collection and analysis method. Asking a specific question would negate the purpose of using grounded theory, because in grounded theory the main idea or question of interest emerges from the data collection and analysis process. Thus, a main idea is being created, not tested, and the research process itself is the framework.

During the construction of the interview guide some general open-ended questions relating to risk perception were included as a way of initially understanding the factors important to the respondents. The interview guide is shown in Appendix A. Concepts of risk perception such as controllability and familiarity were used to structure some of the questions. In addition, general questions of exposure, and use of preventive measures were asked as basic initial questions.

Grounded theory was used in the data collection and analysis stages of the project. This approach was chosen because the area of hantavirus risk perception and risk reduction had not been previously studied, therefore there was no existing hypothesis to test. Grounded theory was considered to be flexible enough to discover farmers' and forest professionals' perceptions of hantavirus risk and how this may influence risk reduction for this group. The assumption was that a structured questionnaire with a predetermined hypothesis to test would limit understanding the complexity of the issues or risk perception and risk reduction for farmers and forest professionals.

In the interpretation stage a combination of grounded theory, risk perception, and the health belief model were used to understand the conceptual framework that had developed through this research process.

Table 3-1. Description of the theoretical frameworks used in this study

Stages of the Research Process	Theoretical Frameworks		
	<i>Grounded Theory</i>	<i>Risk Perception</i>	<i>Health Belief Model</i>
Research question development	✓	✓	
Construction of the interview guide		✓	
Data collection	✓		
Data analysis	✓		
Interpretation of results	✓	✓	✓

Grounded theory was the main theoretical framework useful in this research study. However, contributions from risk perception and the health belief model were used at varying stages of the research process.

DESCRIPTION OF THE RESEARCH METHODS

In grounded theory data are collected by conducting interviews, typically 20 to 30 interviews (Patton, 1990). The interviewee is considered "the expert" because he or she has a complex stock of knowledge about the topic under study (Gorman & Clayton, 1997; Flick, 1998). The researcher chooses participants who possess knowledge of the subject because of their life experiences (Hutchinson & Wilson, 1994). Detailed, in-depth information can be obtained from subjects' perceptions of events, processes and environments; and understand the meaning people have for their everyday activities and life (Marshall & Rossman, 1995; Gorman & Clayton, 1997). Using this method, the researcher is able to ask questions about what cannot be directly seen or observed, such as thoughts and intentions; and previous behaviours and experiences (Patton, 1990).

Sampling

Participants selected for inclusion in this study were forest professionals and farmers who work in Alberta's boreal forest and who had previously heard about hantavirus. These inclusion criteria were necessary to ensure that individuals could respond to issues related to their knowledge of hantavirus, use of preventative measures, and risk perception. Forest workers and farmers were specifically chosen as occupational groups to study because they potentially have a greater risk of exposure to hantavirus in Alberta's boreal forest, compared to the general public (refer to chapter 2). An additional inclusion criterion was based on their exposure. Forest professionals or farmers were considered for this study if they had potential occupational exposures. Occupational tasks such as working with or being exposed to deer mice, and living conditions such as cabins, trailers, or field camps were the initial exposure situations identified as risks for farmers and forest professionals. Also included in this group were government officials who were involved in policy decisions regarding hantavirus issues in Alberta and Canada, and/or who dealt with the public and their concerns regarding hantavirus. Information from these individuals was used to triangulate the information gathered from the farmers and forest professionals.

Eleven forest professionals were interviewed between April and July, 2000. Table 3-2 shows a breakdown of the categories of forest professionals and the locations where

they worked and lived when they were involved with forest related activities. The location was based on the Regional Health Authority (RHA) designation. This served two purposes: to identify the general location in northern Alberta while protecting the identity of the participants; and to identify where these participants worked in relationship to where the cases of hantavirus pulmonary syndrome (HPS) had occurred (refer to Figure 1-4 for a map of the RHAs).

Table 3-2. Description of the Forest Professionals

Interview	Occupational Description	Location based on Regional Health Authority
FP 1	Wildlife Biologist	RHAs 11-17 (northern Alberta)
FP 2	Forest Technician	RHAs 11-17 (northern Alberta)
FP 3	Forest Technician	RHAs 11-17 (northern Alberta)
FP 4	Wildlife Biologist	RHAs 11-17 (northern Alberta)
FP 9	Forest Officer	RHA #11
FP 11	Forest Officer	RHA #11
FP 12	Trapper	RHA #11
FP 13	Forest Operations Manager	RHA #8
FP 15	Wildlife Biologist	RHA #13
FP 17	Trapper	RHA #11
FP 19	Wildlife Biologist	RHAs 11-17 (northern Alberta)
Total number of forest professionals interviewed = 11		

Of the eleven forest professionals interviewed four were wildlife biologists, two trappers, two forest officers, two forest technicians, and one forest operations manager.

Nine farmers were interviewed between May and July, 2000. Table 3-3 is a break down of the locations where the farmers lived and worked. As with the forest professionals, the description of the location was at the level of the Regional Health Authority (RHA). Refer to Figure 1-4 for more detailed information on the RHAs.

Table 3-3. Description of the farmers

Interview Number	Location based on Regional Health Authority
FA 10	RHA #11
*FA 16	RHA # 7
FA 18	RHA #7
FA 20	RHA #13
*FA 21	RHA #11
FA 22	RHA #11
FA 23	RHA #11
FA 24	RHA #8
*FA 25	RHA #13
Total number of farmers interviewed = 9	

*Farmers who had contacted Hantavirus Pulmonary Syndrome

Of the ten farmers who were interviewed, three had actually contracted hantavirus pulmonary syndrome. Each was from a different Regional Health Authority. There was one farmer who did not work in the boreal forest but who was included in the study: FA 16. This was a farmer who had hantavirus infection, who was included at the suggestion of one of the health officials. Because this person had hantavirus it was thought that he would be able to provide an interesting prior and post perspective on hantavirus. It was not intended to interview farmers who had hantavirus, not because they would not be appropriate respondents but because there was no certainty that the researcher would be able to gain access to this group to interview with them. However, since the health official was going to approach the farmer to ask permission on behalf of the researcher, this farmer was included in the study. At that time there was no indication that other farmers who had hantavirus would be recruited. This is also characteristic of the "snowball" approach to sampling.

In addition five interviews were conducted with various government officials, one by telephone, and the remaining four conducted in-person. One government official was from the agricultural sector and the other four were from the health sector. The information they provided was used to triangulate the data received from farmers and forest professionals. The interview guide used when interviewing these respondents is provided in Appendix B.

Recruiting Participants and Data Analysis

Research participants were initially recruited by personal contacts in the forestry and farming industry. Those initially contacted either agreed to participate in the study or identified others who fit the criteria and whom they thought may have been interested in participating.

Participants were contacted by telephone. Those who were interested or agreed to participate were sent an Information Sheet (refer to Appendix C) and Consent Form (refer to Appendix D) by fax, mail, or email. An appointment was set to conduct the interview on a particular day and time. Interviews were conducted either in person or by telephone. Of the nine farmers who were interviewed, four telephone interviews and five in-person interviews, were conducted. For the forest professionals there were two telephone interviews and nine in-person interviews, for a total of eleven interviews with forest professionals.

All interviews were taped on an audiotape cassette so that verbatim transcription could be performed. At the time of a telephone interview, verbal consent was received from the participant and recorded on tape. Most of the participants who did telephone interviews also submitted a signed consent form by mail. Thus, there were two methods documenting their consent to participate in the study. Consent forms were gathered from participants at the time of the interview, when it was done in person.

The length of time to conduct each interview varied considerably from a minimum of forty-five minutes to a maximum of three hours. In general, most interviews were about 75 to 90 minutes.

All participants were asked the questions outlined in the interview guide. However, these were fairly basic and generic questions. Thus, as different categories began to emerge the emphasis of the interviews shifted to those emerging categories. After each interview the main points were documented either in writing or audiotaped. Verbatim transcription was done as soon after the interview as possible so that emerging categories could be identified and further explored in the next interview. However, there were occasions where time did not permit a transcription of the interview prior to the next interview. As a result, the audiotaped interview was studied by listening to it again and notes were made documenting the key points and areas that needed further clarification and understanding. This process was a necessary component to developing the theoretical framework.

In-depth analysis was performed on each interview using Ethnograph version 5.0 theme analysis software. Line by line coding was done to elicit all the relevant information. The codes were compared to identify and link similar sub-categories and categories. This was a continuous process to refine each of the categories. Then categories were compared to determine themes. This process was also continuous and refined with each interview.

As each category emerged or was discovered from the data, a conceptual diagram was developed for each of them identifying the factors that influenced that particular category or theme and the consequences of that influence. This process of discovery and theory development, as described by Strauss and Corbin (1998), assists in understanding how each category related to each other.

A. Theoretical Sampling of Forest Professionals

Initially, forest professional contacts were recruited for an interview. These included two wildlife biologists and two forest technicians. The focus of these initial interviews was to understand the source of hantavirus information and knowledge about the virus. This quickly proceeded to a need to understand specific ways that these forest professionals came in contact with deer mice while on the job. However, during these initial interviews a number of barriers to using preventive measures were also identified. The next step was to recruit participants who may have had some similar biology field experiences, to

further explore the barriers they faced using precautionary measures while in the field. Thus, an email was sent to all graduate students in the Department of Biological Sciences at the University of Alberta, explaining the purpose of this research project and requesting their participation. The Information Sheet and Consent Form were also sent at this time. The reason for contacting this group of individuals was because it was thought to be the easiest and most efficient way to recruit individuals who would have biological field experience. From this process only one response was received. This low response could have been as result of students already being out in the field. At this time another personal contact that had considerable biological field experience, agreed to participate in the study. This individual was asked more specific questions relating to barriers and perceptions of hantavirus risk. It also included an in-depth discussion of personal risk perception and those of colleagues. In addition, there was considerable discussion about recommendations for action.

B. Theoretical Sampling of Farmers

The initial farmer in this study was contacted through a forest professional contact. This first interview with a farmer was highly exploratory and covered all the questions in the interview guide to gain some familiarity with farmers issues related to exposure.

The researcher felt that considerably more knowledge was needed regarding farmer's exposures; thus, a contact was made with Alberta Agriculture to explore these issues. This interview proved invaluable in understanding the specific tasks and places on a farm where farmers could be potentially exposed. The researcher was now prepared to ask specific exposure questions when interviewing farmers, because a baseline knowledge was now established.

At about the same time a health professional contact recommended that the researcher interview a farmer who had hantavirus. She contacted this person on behalf of the interviewer to obtain permission from the farmer for a further consultation. This farmer agreed and this led to a second interview with a farmer. Information was gathered on this farmer's experiences with hantavirus. This included how he came in contact with the virus; what his perception and knowledge of hantavirus was before he got it and how this might have changed; the level of precautionary measures he took previous to

contracting the virus and current practices; and his role as someone who is knowledgeable on hantavirus in disseminating this information to others.

In addition, various agricultural associations were contacted to see if they knew of anyone who would be interested in participating in this study. Information sheets and consent forms were sent to these contacts so they could pass them along to others whom they thought might be interested. Through this process three more farmers were recruited to the study, one of whom had contracted hantavirus. In the process of contacting various agricultural organisations the researcher was invited to participate in a Farm Safety Day Camp. It was suggested that this might be a resourceful venue to meet and speak with farmers as well as participate in the Day Camp. Through this process four more farmers were recruited, one of them who had contracted hantavirus.

ENSURING TRUSTWORTHINESS OF THIS STUDY

Methods to ensure the trustworthiness or merit of qualitative research are necessary to establish rigor. A method often used by qualitative researchers to establish rigor in their work is based on a model of trustworthiness proposed by Guba (1981). This model identifies strategies for ensuring trustworthiness: credibility (truth value), dependability (consistency), and confirmability (neutrality). The criteria used in this study to establish these three strategies were prolonged engagement, reflexivity, triangulation, member checking, and peer examination.

Prolonged engagement

This is a term described by Lincoln and Guba (1985) for ensuring that the researcher spent sufficient time with respondents to identify and verify recurrent patterns or concepts. This criterion was used to establish credibility. This served the purposes of the respondent becoming accustomed to the research and increasing rapport as well as allowing sufficient time to check perspectives. The assumption is that as rapport with the respondent increases, respondents may be more willing to share their experiences (Krefting, 1991). Rapport building began prior to the interview when the researcher contacted the respondent. It was at this time that the project was described to the respondent and the respondent was given the opportunity to ask questions. The researcher found that explaining that this study had been reviewed by an ethics

committee at the University of Alberta was important in establishing credibility and worth of the project. The process of rapport building continued as the project and consent were further discussed and respondents were again given the opportunity to ask questions.

At times during the interview the researcher checked the perspectives of the respondent and asked for clarification by paraphrasing what was said and asking if that was an accurate reflection of their perspective. This process gave the researcher confidence in knowing that what was being heard and understood was in fact what the respondent was trying to convey. The checking of perspectives and clarification continued after the interview in some cases, when the interviewer was reviewing the audiotape or reading transcripts. Where necessary, respondents were contacted again to provide clarification on their comments.

Reflexivity

This criterion establishes credibility and confirmability in the research process. Reflexivity involves the researcher assessing their own perceptions and background, for the researcher is part of the research and not separate from it. Therefore it is important to assess this in the context of the research (Krefting, 1991). At the end of each interview the researcher audiotaped the outcomes of the interview which included a reflection of the interview and its process. Sometimes a written record of these reflections was kept when it was not convenient to use a tape recorder.

Triangulation

The process of triangulation is used to establish confirmability, dependability and credibility in the research. This involves the idea that multiple perspectives can be used to ensure that many aspects of a concept have been examined and that there is mutual confirmation of the findings (Krefting, 1991). Triangulation of data sources occurs when data collected from various sources are compared. The main method of data collection was semi-structured interviews with farmers and forest professionals. However, data were also examined from media sources such as newspaper articles, and the internet to identify the types of hantavirus information that were being disseminated to the public. In addition, semi-structured and informal interviews with various government officials disclosed the types of concerns the public had regarding hantavirus and the types of

questions they were asking. Triangulation of data sources also occurred by comparing two groups: farmers and forest professionals. This assisted in identifying the similarities and differences between these groups and enhanced the diversity of perspectives observed.

Member checking

Member checking is a highly effective method of establishing credibility. This technique solicits feedback from participants. Two participants were asked to review the emerging theory and provide their feedback on how closely this theory represented their experience.

Peer examination

This was a process used to establish credibility and dependability. The researcher discussed the research process and findings with impartial peers who were familiar with qualitative research methods (Krefting, 1991). Throughout the study the researcher discussed interview guide development, interviewing techniques, and data collection and analysis techniques with peers. A government official from Alberta Agriculture assisted in suggesting ways to gain entry and increase rapport with farmers. The researcher approached graduate students and a social worker who were familiar with qualitative research to check the categories that emerged from the data. They assisted in examining the categories and assessing whether codes accurately reflected categories. Three researchers familiar with qualitative research were also asked to separately code an interview. This was compared against the researcher's own coding to assess accuracy of coding but also to identify additional perspectives on the interviews.

CONCLUSION

This chapter identified the methods that were used in this research study to recruit participants, collect the data, analyse the data, and construct the theory. It also provided a justification for using grounded theory as a research method. The processes for building trustworthiness in this research were also discussed.

CHAPTER 4: RESULTS

INTRODUCTION

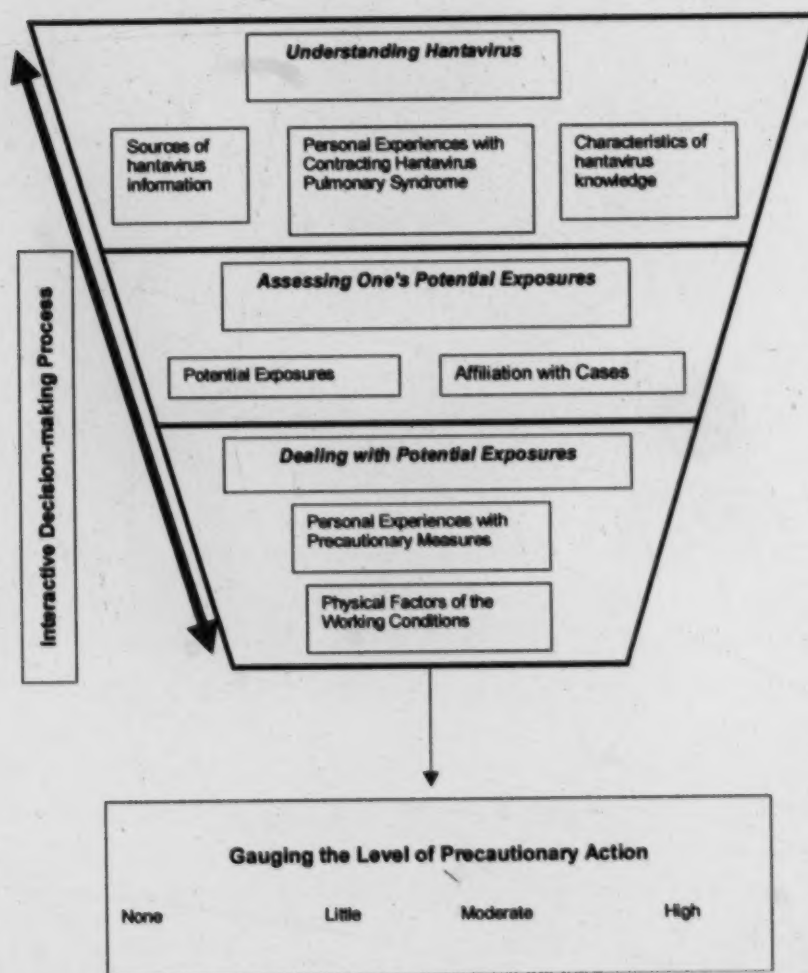
This chapter describes the results of the study based on the objectives that were outlined in chapter 2 and the grounded conceptual framework that was developed. Although the initial intent of the study was to construct a theory that would provide insight into farmers' and forest professionals' perceptions of their risk to hantavirus and then determine means of reducing their risk, this was only part of the conceptual framework that was developed. The results as they emerged from the data developed a grounded theory framework that focused on an interactive decision-making process and the components that influenced farmers' and forest professionals' decisions to take precautionary actions. Thus, the conceptual framework was taken to a broader level than expected. Risk reduction recommendations did emerge from this process.

THEORETICAL DECISION-MAKING PROCESS FOR GAUGING THE LEVEL OF PRECAUTIONARY ACTION: AN OVERVIEW

The twenty in-depth interviews conducted with nine farmers and eleven forest professionals provided a theoretical framework that identified the components of a decision-making process to gauge the level of precautionary action. This framework is an interactive decision-making process.

The components of the decision-making process, as shown in Figure 4-1, are divided into three main groups: understanding of hantavirus, assessing one's potential exposures, and dealing with potential exposures. The central category or outcome of each of the three main categories is gauging the level of precautionary action.

Figure 4-1. Decision-making process to gauge the level of precautionary action



COMPONENTS OF THE GROUNDED THEORY MODEL

Gauging the Level of Precautionary Action: The central component of this theoretical framework

The central category identified in this conceptual framework is gauging the level of precautionary action. In this context the word "level" was chosen to mean the amount and appropriate kind of precautionary measure that each respondent decided to take. This "level" was based on their understanding of hantavirus, their assessment of the potential exposure, and the way they decided to deal with their potential exposure. This process assisted them in making a decision about the precautionary action to be taken. Farmers and forest professionals alike knew the measures they should take and identified some of the measures that they did take. However, the complexity of this central category lay in their uncertainty with knowing when to take certain precautionary actions and when not to; and which potential exposure situations required taking which types of precautionary actions. This uncertainty in knowing how to make a decision stemmed from many of the uncertainties individuals had with trust and confidence in the knowledge about hantavirus, the efficacy of precautionary measures, and truly understanding when they could avoid taking measures and when they should be quite careful.

The sections to follow discuss each of the three main categories that emerged from the data and how they contributed to the respondents' decisions about the level of precautionary action to be taken.

Understanding Hantavirus

In this main category, "understanding hantavirus", forest professionals and farmers described the hantavirus knowledge they acquired from various sources, the characteristics of this information, and a description of the personal experiences of farmers who contracted hantavirus. The word "understanding" is defined as, "to learn", "to take as fact", "and to know the nature" of a phenomenon. Thus, through this process farmers and forest professionals found their way within a complex body of knowledge in

an attempt to learn about the facts and bring meaning to its effects on their daily occupational tasks.

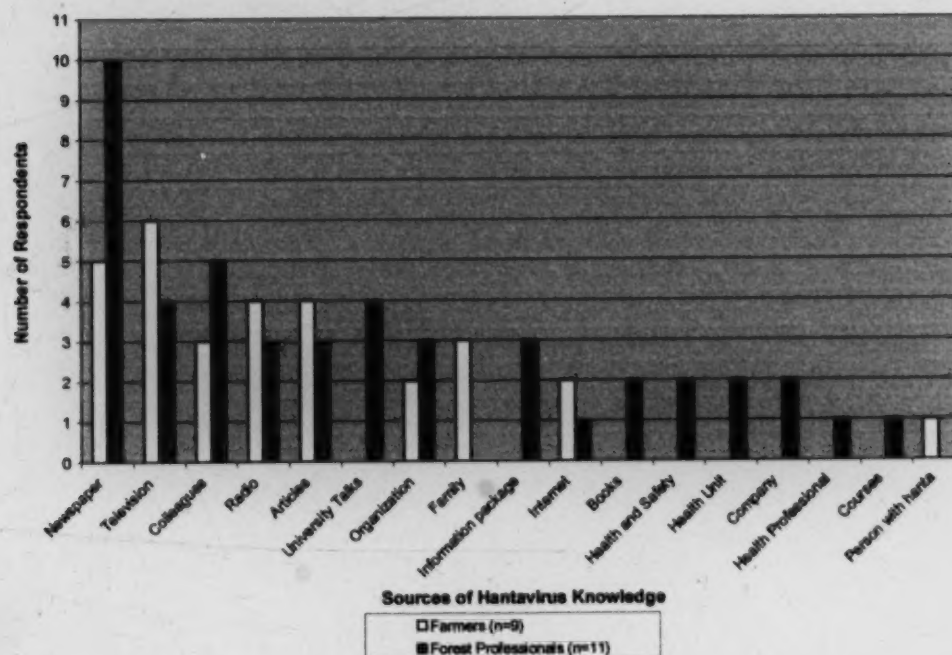
A. Sources of hantavirus information

The context within which farmers and forest professionals gained an understanding of hantavirus was through various sources that disseminated hantavirus information. First, a description is provided of all the sources of hantavirus knowledge identified by farmers and forest professionals (Figure 4-2 and Table 4-1).

The following figure (Figure 4-2) illustrates the sources of hantavirus information as identified by farmers and forest professionals. Farmers identified the television, newspapers, the radio and periodicals such as farmers' journals, magazines, or news bulletins as the four main sources of hantavirus information. However, farmers also identified discussions with colleagues; warnings from family members to take care while working in dusty environments and grain bins; information disseminated by various farming organisations and the internet; as well as speaking with others who have actually had hantavirus, as other sources.

For forest professionals the newspaper was the main source of information. Other sources identified by this group were diverse and included their colleagues; university talks, such as special lectures or seminars particularly targeting field biologists; television; radio; journal articles; information from the internet, trapping courses, books, and information packages provided to government officials or employees of private companies; and health and safety committees. They also obtained information through the health care system such as health units and health professionals. One of the forest technicians said that a colleague who had become relatively concerned about hantavirus and the potential job-related risks decided to further investigate this topic and put together a package of information for the team and other interested individuals.

Figure 4-2. Sources of Hantavirus Information



In general, both farmers and forest professionals received information on hantavirus from various media sources: television, newspaper, and radio. The main media source for farmers was the television as compared to forest professionals, who identified the newspaper. These findings are similar to those from the study done by Predy et al. (1997). Their results found that respondents identified the television (74%) and newspaper (57%) as the primary sources from which people remembered hearing about hantavirus. The radio was a source of information for fewer people (33%) (Predy et al., 1997).

There are two properties of sources of hantavirus information that have relevancy to farmers and forest professionals understanding hantavirus: whether they actively or passively acquired information; and the influence of source of information.

Active vs. passive acquisition of information

Both forest professionals and farmers accessed hantavirus information through active and passive means. The word "active" implies the action of physically seeking out information. However, "passive" on the other hand, does not involve action on the part of the individual to access information, but instead the individual is merely a recipient of information. Table 4-1 provides examples of the sources where farmers and forest professionals actively and passively acquired hantavirus information.

Table 4-1. Active and passive methods of accessing hantavirus information.

Actively Accessing Hantavirus Information	Passively Accessing Hantavirus Information
University talks	Newspaper
Articles	Television
Colleagues	Radio
Internet	Organisation
Books	Family
Health unit	Information package
Health professional	Health and safety committee or group
Person who had contracted hantavirus	Company
	Courses

Actively accessing hantavirus information indicates that these individuals were seeking out this information because they had heard about hantavirus and wanted to be better informed about the virus and the risk factors. Therefore, they attended talks, read articles in journals or books, searched for the information over the internet, or asked professionals or others whom they thought might be knowledgeable on this topic. For example, one farmer talked to another farmer who had contracted the virus. He asked about the disease itself, the victim's experience with the disease and how he had come in contact with the virus. Farmers who had contracted hantavirus also said that other farmers and professions contacted them to inquire about their experiences with hantavirus.

Actively acquiring hantavirus information had some bearing on their level of concern about the topic. However, this involved discerning whether or not hantavirus had some

degree of relevance to their life. If it did, then individuals had some motivation to act on this aspect, that is, they were concerned enough to actively seek information. They undertook this process to learn more about the virus, how it may affect them, and to answer any questions or concerns that were not resolved from previous sources. A wildlife biologist described his motivation to learn more about hantavirus when he first heard about it.

"I don't remember if it was a symposium or a couple of talks, but it was at the U of A. It must have been four or five years ago now. I know that there were at least two talks. One was from some expert from the U.S. But I went because we were doing quite a bit of mammal work at the time and I was concerned about it."

(FP 4)

This forest professional was concerned enough to further educate himself on this issue at a time when he felt he may be potentially exposed to hantavirus while working on field research projects. In addition, he read literature from various sources to continue to educate himself on hantavirus. After attending the seminars and reading up on hantavirus, he felt more informed about his own potential exposure. This process increased his understanding of his level of exposure and reduced his level of concern for hantavirus. Thus, he was able to make an informed decision regarding taking precautionary measures.

Forest professionals and farmers described passive acquisition of hantavirus knowledge occurring through various media sources, their families; and information provided in the work environment, such as from information packages, courses and information from health and safety committees. In these cases they were not seeking information on hantavirus but rather this information was brought to their attention by these sources.

The outcome of those who initially "passively" heard about hantavirus was to either learn more about it by actively seeking additional information, or continuing on a path of inaction. They were either not concerned or worried enough about hantavirus to educate themselves further, or felt that their own level of exposure was very low.

Whether a farmer or forest professional actively or passively sought information on hantavirus gave some indication of their level of concern for hantavirus. Actively seeking hantavirus information indicated a higher level of concern, whereas passively acquiring

this information with no intention of seeking additional information indicated a lower level of concern. This lower level of concern however did not suggest that farmers or forest professionals were going to take little or no precautionary measures. Some were satisfied with the information they received "passively". They felt informed and they also felt that they had received sufficient information to take some level of precautionary action. The outcome for some whom had received hantavirus information actively was that either their level of concern continued to remain high or it decreased. It remained high if they perceived their exposure to be high, or decreased if they perceived that their exposure was low. A higher level of concern led to some or more moderate levels of action. And a low level of concern led to a farmer or forest professional taking little or no precautionary action.

Influences of the information sources

The various sources of hantavirus information influenced farmers and forest professionals in different ways, in terms of their understanding of hantavirus. These sources were discussed by the respondents as three main concepts: media coverage, peer support, and soliciting advice from professionals.

1. Media coverage

This was one source of influence for respondents. There were two major aspects of the media coverage that respondents identified: the timing of the media coverage and the focus of this coverage.

The timing of media coverage was related to the time of year that the media, such as television, newspapers and radio, had announcements on hantavirus. Farmers recalled hearing about hantavirus in the spring and fall, cautioning them to be careful during various spring and fall farm activities. Farmers and some forest professionals felt that this was an appropriate time of year to hear these reminder messages. At this time farmers would be cleaning up storage sheds that were not used over the winter or summer, or using equipment that was abandoned for some months. For example, grain trucks are only used occasionally therefore there is ample opportunity for mice to nest in them.

"It was the fall. And I mean that's a great time of the year to run those types of articles because your farmers are all out in the field. You're all working on your grain, which is where your mice are going to be living. You're putting up your hay. And of course your mice are going to like that type of thing. So, the fall was a good time to write up the article. Even the spring when you start to do some of your spring clean-ups. You clean up your little storage sheds or wherever you've been storing things. And maybe at that time it should be brought out again into the papers and into the media just so that people have more of an understanding that it is there." (FA 10)

One farmer acknowledged the efforts of Alberta Health and the media in providing the public with hantavirus information during the spring, summer, and fall.

"Alberta Health got in there and started talking about it. And then the media. Especially in the Fall, Spring, and Summer. That's when they should be telling people. I think they've done a pretty good job with it." (FA 16)

This farmer felt that Alberta Health had done a good job in providing the information during these specific times of the year, because previously every spring he would personally communicate with the media to remind people about hantavirus. He did this out of his own time and finances. Now Alberta Health is disseminating this information.

Some said that the winter was not considered a time when they would be too concerned about hantavirus because often they were not performing the occupational activities that would put them at risk. And one forest professional, a trapper (FA 12), said that in the winter time their chances of contracting hantavirus from mice excreta in trap boxes were very low because everything was frozen. Therefore, he did not perceive a risk of exposure at this time of year.

Targeting of information during the spring and fall makes sense when one observes the times of year that most of the cases have occurred. This does not mean that hantavirus information should not be available year round, rather that information targeting during spring and fall are in fact what farmers and forest professionals both responded to positively.

One of the officials with Alberta Health explained in an interview that disseminating hantavirus information in the spring would be discontinued, because it was not considered effective. However, this time of year was one that farmers and forest

professional felt was appropriate because this is when they anticipate higher potential exposure related to their occupational activities. They appreciated knowing that the information would be available and that it did in fact act as a reminder for them.

Both farmers and forest professionals recalled the timing of news coverage to be related to when an individual had contracted the virus. Some suggested that they had not heard any news coverage on hantavirus in a while, therefore, they assumed that there must not have been any new cases. Some forest professionals and farmers asserted they were more knowledgeable in 1994, when the outbreak started, than they are now.

"Because it was in the news and you read lots and there's a lot more explanation. And it's kind of just died off. There hasn't been too much in the news and that on it." (FP 11)

Thus, the perception is now for some farmers and forest professionals that hantavirus must no longer be of much concern or importance because they no longer hear about it in the news. Some were taking fewer precautionary measures because they felt that hantavirus was no longer an important issue.

The focus of the media coverage recalled by farmers and forest professionals was on the description of the hantavirus cases in terms of how the individual might have been exposed and an emphasis on the severity of the outcome. Some farmers and forest professionals suggested that there was little emphasis on preventive measures, however others suggested that some preventive information was provided. All respondents said that the focus of information provided was mostly on the hantavirus cases. That is, they usually only heard about hantavirus from the media and other sources when someone had contracted and/or died of HPS. Thus, the importance or emphasis of this disease is placed on a case or death. One farmer found this to be unacceptable and often too late, because someone had already died. For one forest professional and one farmer this emphasis only promoted an alarmist view of hantavirus contributing to unrealistic concerns over hantavirus.

"I am concerned that people are just too worried about hantavirus. That some of the literature and perceptions are too alarmist. I believe people should be informed. And they should know if there are risks. But I think they should be put within a perspective that a lot of people have been exposed to it. But only a few

people have contracted it. But it doesn't mean that you can't get it. So here are some precautions you can take. I'm not saying that the information out there necessarily does this. But I don't think you should have people terrified that they won't go outside." (FA 19)

A farmer had a similar response and felt that often times the media coverage was too alarmist. He felt this was an inappropriate way to try to get people to take precautionary measures.

"I don't like the scare tactics approach where every time there is a death or a case that it is made a big issue in the papers". (FA 24)

Thus, the timing of media coverage and the emphasis of its coverage has great influence on the level of concern and behaviour of farmers and forest professionals.

ii. Support from Colleagues

Support from colleagues was another aspect that influenced farmers and forest professionals. Respondents described how colleagues supported each other when it came to general occupational health and safety issues. These individuals seek support, advice and information from their colleagues or community members, as well as share information on various health issues. This was also true for hantavirus. Respondents felt they could turn to their colleagues if they had any questions or concerns to raise or discuss regarding hantavirus. Part of their ability to do this with colleagues was their level of comfort with them because they knew their colleagues would be able to understand their situation. They trusted that these colleagues could provide relevant feedback because they were familiar with the conditions that they worked under, and the tasks that they performed.

One forest professional, a wildlife biologist, said that information about hantavirus would be disseminated through discussions with other wildlife biologists. It was an opportunity to share their views on what to do in the field if they were going to be working with deer mice or could potentially encounter them. She acknowledged that although she had heard about hantavirus from various media sources, they did not discuss very many aspects of prevention. As a result she felt that she received much of her specific

information about hantavirus from seminars at their university and discussions with colleagues.

"And then there's all kind of talk too amongst the researchers because they are dealing with mice. You hear about these stories. So then there's a lot of people who are educated on the issue as well so there's a lot of banter back and forth... On anyone's project that dealt with deer mice, there are always questions about it. Like what do you wear when you're out in the field because there's lots of... 'well some people wear all the gear when they are out slogging through the forest', and then there are people who are like, 'No I don't think it's an issue.' It's been here for a long time and the chances of me getting it are virtually nil. Just walk around with your gloves on just so that you don't get bitten and that's about it.' I think it was more from talking with colleagues. And saying, 'okay this is carried on dried feces and I guess we better not be sweeping or...' Kind of more common sense. Talked about things with other colleagues." (FP 19)

Another wildlife biologist suggested that various groups who were handling deer mice in their various field projects, would share their knowledge on the use of precautionary techniques, such as what worked and what did not work. He described the situation where the biologist he was working for had taken some initiative in communicating with other biologists their experiences with using latex gloves as an effective preventive measure. Other researchers adopted the method.

"Because even the latex gloves I think had become an institution in trapping now. Everyone uses them. Even another company that I worked for in fall of 1997, we were using latex gloves. And we were washing the traps out and everything. I believe in 1994, 1995, and 1996 I was working mostly for the University of Alberta and the Alberta Pacific Forestry Company. But in fall of 1997 I was working for a completely different research company and they used the same procedures that we had developed in 1994, 1995, and 1996. I think it had spread through word of mouth through the colleague connection that they had made. That this is a good way of communicating. And I think everyone does this now." (FP 1)

A farmer said that they also share information amongst each other about the precautionary methods they were using.

"In this community farmers may not necessarily get together to talk about issues around hantavirus but they will say to one another, 'Just be careful because of hantavirus. This is what I am doing' (FA 18)

Another farmer also described the informal nature that farmers communicated information about hantavirus to each other.

"People in the community doesn't really talk about hantavirus. It may be a topic at the barbershop or the coffee place when we hear about some farmer somewhere contracting the disease. Whether it be fatal or not. It may come up. And the discussion may move to, "Have you see lots of mice at your place?" "Yes, but the foxes are keeping them under control." (FA 24)

Farmers who had hantavirus found that other farmers, both from within and outside their communities would contact them to inquire about their potential exposures and the precautions they take. Thus, these individuals were a source of support and local expert knowledge to their peers.

"Would get a lot of phone calls with people being concerned about whether they've got hantavirus if they have a cold. They want to know how it starts out and what to do." (FA 16)

Farmers who had contracted the virus described similar instances where farmers from their community, province or Western Canada had contacted them to learn about hantavirus because they were concerned. FA 16, a farmer who had contracted hantavirus described some of the phone calls that he had received. He stated that the reasons for these farmers calling him were, because they had flu-like symptoms or thought they might have been exposed to the virus and were concerned, afraid, and highly distressed that they might have hantavirus. Thus, they called this farmer to inquire about the initial symptoms and the symptoms they should watch out for.

"Oh yeah, phone calls. I would get people as soon as they sneeze it's like, well what does it start out like. I mean that was panic just simply because the awareness wasn't there. And they thought this thing was going to be... Nobody knew what it was. I've had phone calls from people in B.C. and up in Grande Prairie. I've had people phone me from Regina. I had a phone call from a guy in Saskatchewan last year. He was so mad he had mice in his combine he was going to sell his combine. He pretty well freaked." (FA 16)

As a result this farmer, in addition to being a source of information to other farmers was also a support for them, someone whom they felt was knowledgeable enough because of his own experiences with the virus. He was also someone whom they could trust because being a farmer he was familiar with their jobs and their experiences.

A forest professional shared his concerns about the general lack of support in terms of general health and safety issues for those who worked in the field. Greater attention and effort was spent on the safety for laboratory technicians, rather than the field technicians. Because of this lack of support he said that health and safety issues were left up to the individuals to be responsible for their own safety on the field.

"Most of the people are more concerned with the lab and within the lab, rather than they are with the field work. Which is sort of troubling to some of us because there's a good, least half of the technicians if not more, do field work in some aspect of their job. So, I don't know if it's reflected as much. The amount of people who do field work and the number of health and safety issues that are brought up regarding it is pretty low. So, in fact it's almost up to every individual who's doing field work to sort of police themselves, in the senses that we're doing the job safely." (FP 3)

iii. Soliciting the advice from professionals

Another source that influenced farmers and forest professionals was information from various professionals such as government health officials, public health officers, and forest officers. Interviews conducted with these officials identified the kinds of information that the public, farmers, and forest professionals sought from these officials. The main questions that they asked were how they might become exposed, how would they know if they had hantavirus, and what they should do to prevent themselves from contracting the virus. Thus, they trusted these sources enough to seek information from them. Local public health offices were one of the main facilities that individuals approached because they felt they were familiar with local health issues and concerns. The government officials interviewed from Alberta Health and Health Canada said that any pamphlets or information they have on hantavirus is published on their websites, as well as disseminated to local public health units. Thus, within the health care system it is the local public health units that play a significant role in communicating hantavirus information to the public, including farmers and forest professionals.

B. Characteristics of Hantavirus Knowledge

The next section describes the specific knowledge that farmers and forest professionals recalled hearing about from various sources. Most respondents interviewed were fairly knowledgeable about the key issues or messages related to hantavirus. These key

messages were coded in the sub-categories for the descriptions of hantavirus knowledge. They are general HPS case information, knowledge of transmission, physiological factors, and knowledge of preventive measures. Table 4-2 lists the sub-categories and examples for describing the hantavirus knowledge of farmers and forest professionals.

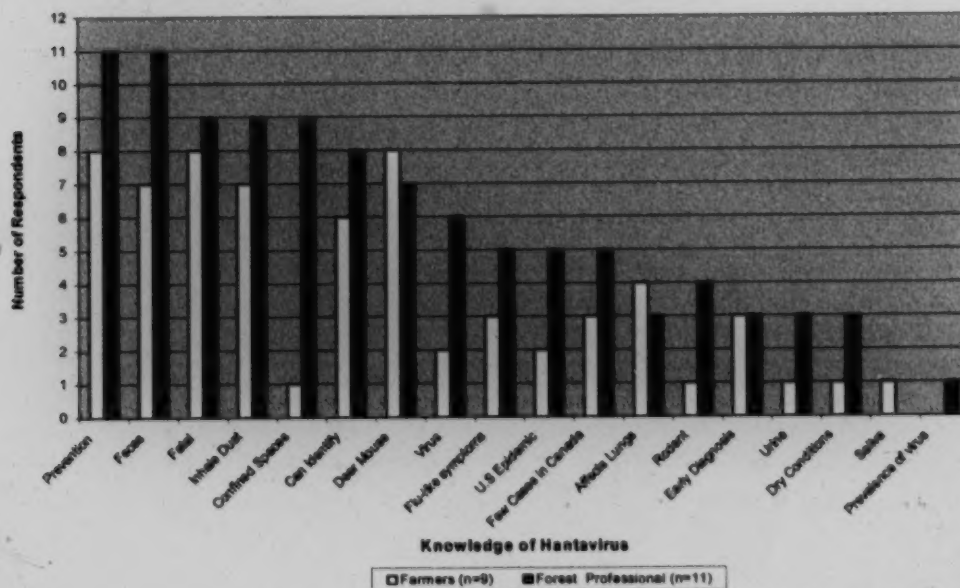
Table 4-2. Sub-categories for the descriptions of hantavirus knowledge for farmers and forest professionals.

Sub-categories for the Descriptions of Hantavirus Knowledge			
General Case Information and Description	Knowledge of Transmission	Knowledge of Physiological Factors	Knowledge of Preventive Measures
U.S Epidemic	Rodent	Fatal	Recalled some preventive measures
Few cases in Canada	Deer mice	Flu-like symptoms	
Prevalence of the virus in Canada	Can identify	Early diagnosis	
	Virus	Affects the lungs	
	Feces		
	Urine		
	Saliva		
	Inhale dust		
	Dry conditions		
	Confined spaces		

Figure 4-3 illustrates the frequency of the examples described in Table 4-2. For forest professionals all of them said they were knowledgeable about prevention practices and knew that hantavirus was spread through the feces of mice, some being aware that it was specifically transmitted by deer mice. Nine of eleven of them also knew that the mechanism of contagion to humans is by inhaling dust particles. Therefore, they believed that being in confined or enclosed spaces posed a potential risk of exposure. Many of them also knew the severity of outcome for this disease; fatality. This was some of the main information that forest professionals described. Figure 4-3 lists others.

Many of the farmers were also aware of the prevention practices, knew that hantavirus was carried by deer mice, and knew that mortality could be an outcome for this disease. In addition they also knew that hantavirus is spread through the feces of deer mice and inhaling dust particles is what could result in one being exposed to hantavirus. Figure 4-3 lists other information on hantavirus that farmers and forest professionals were knowledgeable about.

Figure 4-3. Knowledge of Hantavirus Identified by Respondents



In general, forest professionals and farmers were fairly knowledgeable about hantavirus.

General HPS Case Information

The types of information that were coded for this sub-category were the epidemic in the United States, the number of cases forest professionals and farmers had heard about in Canada, and the prevalence of the virus in Canada.

Five out of eleven forest professionals had heard about the epidemic in the United States that occurred in the Four Corners region. In contrast, only two of the nine farmers had heard about this epidemic. All of these individuals recalled that it occurred sometime in the early part of the 1990s. Essentially these respondents were aware that

the virus was "first discovered in the United States" (FA 15). Many of these respondents, both farmers and forest professionals, described hantavirus as a relatively "new disease" because no one had heard about it before and there did not seem to be much knowledge about the disease, especially when it first came out. When both groups were asked if they had heard about any cases of HPS in Canada or Alberta, all the respondents said that they had. One forest professional said that there is a greater prevalence of the virus in western Canada as compared to the east. This respondent thought there might be a few cases out east but was uncertain.

In contrast, two forest professionals said that from an ecological point of view hantavirus has been around for a long time, therefore, it was not considered a risk or something to become overly concerned and worried over.

"I believe that hantavirus has been around for a very long time. I think that there has already been a lot of exposure to humans with animals that carry hantavirus. And I think the risk is very low of actually contracting it." (FP 19)

And when speaking with colleagues there was a similar sentiment expressed:

"Usually there would be a bit of a discussion, 'well do you really think there is a risk or has hantavirus just been around for such a long time?' Because we usually think about it in ecology terms. It's been around for a long time. Mice have always probably been carrying it. Just because it's newly discovered doesn't mean that it's a new virus existing in our environment." (FP 19)

Thus, those who viewed the virus as something that was "new" had a higher level of concern about hantavirus compared to those who viewed this disease as something that had been around for a long time and therefore is part of the natural ecological cycle of the environment. Thus, they were less concerned about hantavirus being a risk to them or anyone else.

Another factor that both groups of respondents recalled regarding information about Alberta cases was the actual number of cases that they had heard about. Five forest professionals and three farmers said that there were only a few reported cases of hantavirus in Alberta. Therefore, these individuals viewed hantavirus to be a rare occurrence. As a result they perceived the disease itself to be of low risk to themselves and others.

On the other hand, two farmers said that although the number of cases in Alberta may be very few, for them it was in fact too many and something that could have been prevented. One farmer said that the number of cases particularly in Alberta is too high. That when they heard about the first case of hantavirus they did not pay too much attention to it and simply considered that event to be an isolated incident. However, when they heard about more cases, they became more concerned and began taking some precautionary measures.

"That we've had mice for so long and there hadn't been any major problem. And we considered it a major problem even though the numbers aren't so high. They are just far too high. But it appears that it was rare. And now we don't consider it to be rare at all. The fact that there are twenty cases. And I'm almost surprised. One third of these cases are fatal. In our case we know already two that have passed away from it." (FA 18)

For some, the number of cases that they have heard about was considered rare, because of the actual numbers. Therefore, for them the likelihood of actually contracting the virus was very small, and their level of concern low, because they felt it was something that had a low chance of occurrence. Others felt that although the number of cases may have appeared to be few to some, it was in fact too high or too many for them. Also, at one time it may have seemed to be low, because they had only heard about one or two incidents. However, once they began to hear about more cases among people they knew, their level of concern changed. As a result, the number of cases was significant to them and contributed to their increased level of concern about hantavirus, because there was a personal association and familiarity with the cases. Something that had been unfamiliar was now more real and familiar to them.

Knowledge of Viral Transmission

Farmers and forest professionals were very knowledgeable concerning the epidemiology of the virus and the conditions that may have increased potential exposure. Six out of eleven forest professionals and two out of nine farmers knew that it is a virus that causes HPS in humans. All the farmers interviewed specifically named the deer mouse as the carrier of the hantavirus, and all except two forest professionals responded this way. These two forest professionals knew that in general a mouse transmitted the virus.

When asked if they would be able to recognise a deer mouse if they saw one, six farmers and eight forest professionals said that they would. All the forest professionals and seven out of nine farmers knew that the virus was transmitted in the feces of the mouse. Three forest professionals and one farmer identified that the virus could be transmitted through deer mouse urine. In addition, one farmer suggested that they had read on the internet that the virus could also be transmitted by mouse saliva. Nine out of eleven forest professionals and seven out of nine farmers knew that the virus was airborne and, therefore, could be transmitted to humans through dust and other airborne particulates. Thus, they recognised that the virus could be transmitted to a human through inhalation. Because inhalation is the route of entry, three forest professionals and one farmer suggested that dry conditions would make it easier for the virus to be airborne through dust and other airborne particles. Another condition that was identified as increasing potential exposure to the virus was confined spaces. Nine forest professionals and all the farmers alluded to the concept that confined spaces versus being in the open air or outdoors could increase your potential of exposure to the virus.

Therefore, farmers and forest professionals did have some knowledge of the conditions under which the hantavirus is transmitted. Theoretically because they understood some of the situations that would increase the likelihood of exposure to the virus, they would be able to identify areas of potentially greater risk of exposure than others. That is, dry environments and confined or enclosed spaces were two criteria that they identified as reasons for increased exposure.

Knowledge of Physiological Factors

Some of the knowledge about the physiological factors related to hantavirus were the effects on the lung, general symptoms, and the severity of the disease. Three forest professionals and four farmers knew that the virus affected the lungs in some way. Five forest professionals and three farmers had some general ideas about symptoms and suggested that those who came down with the virus experienced flu-like symptoms. Both farmers and forest professionals were very aware of the severity of the disease, with eight and nine, respectively, suggesting that the HPS could be fatal. However, three farmers and three forest professionals said that early diagnosis was important in trying to save the person's life if they did contract the disease. Because the disease

progressed so quickly, being able to diagnose it earlier would allow health professionals to initiate supportive care earlier rather than later. Early diagnosis was especially important to one farmer, because he felt that this could have saved the life of someone he knew who had died of the virus.

"What I have heard is that when you're got the virus it's like a very bad flu. But the biggest problem is that's what people think it is. And in fact that's what some of the doctors thought it was at the time. So they were not treated for the virus early enough. And so that's why we have felt the death did happen". (FA 18)

In addition, a forest professional expressed his uncertainty with the existing knowledge on hantavirus prevalence and the true number of people who probably have the disease.

"I don't have any evidence. And uh... All I have is strong suspicion that most people who probably have it probably don't report it because they don't get sick. When people who come in contact with small mammals and that, like farmers, they have to have a lot of exposure. And I mean there's like only one case in Alberta or something. I mean I think it's like a lot of flus. Most people get over them and the rare person dies from them. I think it's that sort of thing. But, I guess I'm a little concerned. Mostly because I don't think that there is very solid evidence of how prevalent it is? How many people are exposed and walk away with the sniffles or something? You know, I would be more comfortable if I had more solid data on that." (FP 4)

Knowledge of Preventive Measures

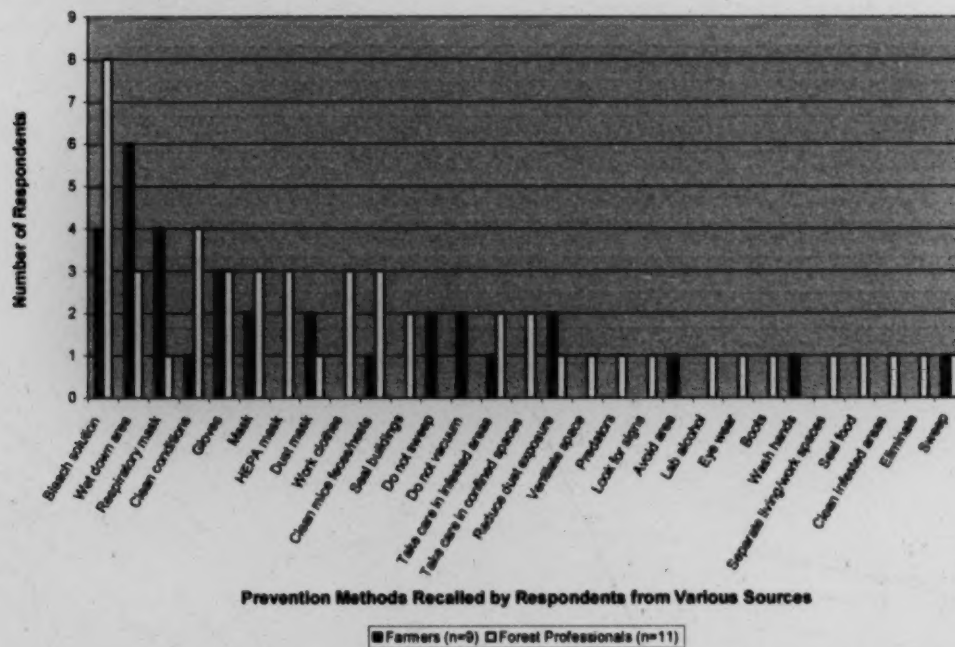
Farmers and forest professionals had varying degrees of knowledge of preventive measures that they had heard from the various sources. Table 4-3 lists the sub-categories for the category on knowledge of preventive measures. The examples coded that describe this sub-category are also listed.

Table 4-3. Categories and lists of examples about knowledge of preventive measures

<i>Categories for the Knowledge of Preventive Measures</i>		
Actions to Take	Actions Not to Take	Equipment to Use
Wet down an area before cleaning	Do not sweep	Use some sort of respiratory mask
Use a bleach solution	Do not vacuum	Wear gloves
Conditions working and living in should be clean		Use work clothes (e.g. coveralls)
Seal buildings		Wear a HEPA mask
Clean up mice feces and nests		Wear a dust mask
Take care in infested areas		Wear a mask of some sort
Take care in confined spaces		Use lab alcohol
Reduce dust exposure		Wear eye wear (e.g. goggles)
Ventilate a closed or sealed area before entering		Wear boots
Keep predators		
Look for signs of the presence of mice		
Avoid an area that may have mice and/or their nests and feces		
Wash hands after touching areas that may have been contaminated with mice and their "products"		
Keep living and work spaces separate		
Keep food sealed		
Clean infested areas		
Eliminate mice and their "products"		
Sweep area		

Figure 4-4 shows the frequency of the examples listed in Table 4-3.

Figure 4-4. Preventive methods recalled by respondents from various sources of hantavirus information



Farmers and forest professionals were able to recall a considerable number of actions that they should take as preventive measures. They were also able to list a number of types of equipment that should be used when taking precautionary measures.

C. Personal experiences: The stories of farmers who had hantavirus pulmonary syndrome

Of the nine farmers and eleven forest professionals interviewed, three farmers had contracted hantavirus pulmonary syndrome. These farmers were asked to recall their knowledge of hantavirus prior to when they became ill. All three farmers recalled hearing about hantavirus from various sources such as television news, documentaries, and family members. All three had heard that a farmer needed to be careful in dusty environments in terms of breathing in the dust; and when performing tasks such as cleaning out an area. In addition, all three had heard that it could be fatal. However, prior to becoming ill, only one of these farmers had heard about farmers in Alberta

becoming ill or dying from this disease and all three had some idea that a mouse spread this disease. Two of them knew that it was a deer mouse, and one of them knew that exposure to the deer mouse excreta was what could cause the problem. Two of the three farmers were aware of some level of preventive measures that should be taken. One of them recalled his father telling him to wear something to protect himself when cleaning out the granaries, and remembered hearing about a case. The other recalled watching a television documentary with two farmers in Alberta who had had hantavirus pulmonary syndrome. In this documentary he recalled them mentioning wetting down the area with a bleach solution and wearing a mask before handling mice or their feces.

None of the farmers had taken any precautionary measures at the time of becoming exposed and then developing the disease. The following section provides descriptions of their experiences with the disease.

The Experiences of Farmer 16

This farmer was in his early 30s when he contracted hantavirus pulmonary syndrome. He was amongst the first few cases seen in Alberta. Thus at the time that he became infected there was not much known about the disease.

He first described his perceptions of hantavirus before he became ill. It was in the fall of 1994 that he contracted the virus. Although he had heard about the case where someone had died from the virus, he was not too concerned about hantavirus. He had been around mice so often that it really was not a "big deal". He said that there were so many diseases that could affect a farmer that he was not going to worry about "a little mouse." At the time he had been working cleaning up the granaries and sweeping them out, getting ready for the fall. He had been in some of the smaller granaries that had not been used in a long time, and they were infested with mice excreta and mice. His father had warned him about the hantavirus and suggested that he should wear a mask to protect himself from breathing in the dust. But this farmer felt that these were tasks he was so familiar with, he had done them many times previously and nothing had happened, so he was not going to be too concerned about hantavirus now.

"I remember the ambulance ride up to Edmonton. At that point in time I couldn't breathe anymore. And they were giving me a lot of oxygen, but I still felt like I

couldn't get enough air. I felt like I was suffocating. And that was it. That was it. That's all I remember. I remember coming too a little at emergency. The next thing I remember was regaining consciousness in ICU. That's when I found out I had been basically asleep for a week. At one point during that week when I was unconscious they had called in my family in the morning and told them that I would probably be dead by that afternoon. So the family was called in. It was a matter of 24 hours of whether I would live or die. It was as simple as that. But low and behold I was still going that night. The sad part too is that if I had dropped dead well I won't have known anything about it. But the family, the family is put through hell. I would have got off easy because I won't have known anything.

When I regained consciousness and began recovering I thought that maybe I should buy a 649 ticket because my luck was so good. But my brother-in-law summed it up really good. He said: 'I don't think you have to worry about winning the lottery. I think you already won it by living.' And he pretty much summed it up really good.

About a week later I was finally walking. It took about a year to physically get back into working. Probably a full year. I had troubles with the left side. They figure it's because the lung was collapsed for so long. I couldn't walk. I didn't have any strength. The last thing they were going to try, that day they thought I may not live, was a heart/lung bi-pass. That's what they were going to do to keep me going. But they didn't actually do it. I don't think that I would ever want to go to the hospital again. It felt so good to come home.

As far as being scared. Yeah, I'm still scared of it. It's gotten better. I thought I was ready for the loony bin there for a few years. It was terrible. I think the hardest part was. In October it took me a long time. I think I didn't start working, really working until probably three months after. And then the first time I came in contact with mice after being sick, that was... I thought that might be the end of my career. I figure if I didn't get in there and get at it that would be the end of it. That I would have to do something different. That's how bad it was. And scared. Just scared. I even phoned my doctor up trying to get him to reassure me that it wouldn't happen again. But nobody knows. This thing could happen to you twice. He doesn't think it will. So I'm hoping that I wouldn't. That's basically all I can say is I take precautions when I can. And if it happens that it jumps up and grabs you when you're not ready. Well you just have to deal with it then. And make sure... I mean, you can't walk around scared all the time. I mean I tried it for a while but it don't work. Like if you just slip up and this kind of happens to you unexpectedly, you just kind of deal with it. And go on with life I guess."

(FA 16)

As a result of his experiences this farmer was quite concerned about getting hantavirus again. His aversion to this situation meant that he is quite committed to taking many precautionary measures such as wearing a full-faced mask, gloves, goggles, work clothes and boots. He takes these precautions whenever he feels he may be performing an occupational task that could be a potential exposure. Also because of his

experiences, this farmer and his family have been very proactive in the farming community as well as with other occupational groups who may have potential deer mice exposures, sharing their experiences and use of precautionary measures. Initially he thought that talking about it would help him deal with the experience. However, he stopped doing this because it began to bother him quite a bit. He acknowledged that he wished he had been able to talk to someone about the disease when he was ill, someone who had experienced it and would have had an understanding of what he was going through.

After he recovered they moved out of their home on the farm because they could not get rid of the mice. He felt that it was bad enough that they had to work with the mice all day that he did not want to come home and deal with them there. So, they moved off the farm and bought a house in town. They also got a cat to keep the mice out.

The Experiences of Farmer 21

This farmer was a teenager when he contracted hantavirus. He was amongst the youngest cases seen in Alberta. There are some similarities with the previous case in his description of his physical experience with the disease. He recalled his parents telling his siblings and himself about hantavirus. They didn't really discuss preventive measures but just for them to be aware of the disease, that there was something like it out there. This farmer contracted hantavirus in the spring of 1997.

"I don't get sick very often. And if I do it's just like a flu or a normal thing. I don't usually get diseases as well. At that time I was very active and fairly in shape. And during that time I was very surprised that I could get ill or sick because I was so healthy. I came down with flu-like symptoms. For about three days I stayed at home. I steadily got worse. We don't usually go to the hospital unless it's really necessary. So, I stayed home until basically every time I moved I had to vomit because I got dizzy and my stomach just churned. And to move was very painful, in that when I moved I would get severe headaches and my body would ache. And it was when I changed my equilibrium. So I had to stay even in a lying down position. So I went into...my mother rushed me into the emergency room here in [our community], where they put me in a wheelchair. But I couldn't stay in a wheelchair because my head was up in the air and my blood, for some reason I had to...I got out of the wheelchair and lay down on the floor because for some reason I couldn't sit in the wheelchair. I had to stay even. So they took blood samples from me then. And then I stayed in the hospital room, and seemed to get better for a little while. That Saturday...I went in Saturday afternoon. And my parents left me there overnight and they came back after

church, I started to have a hard time breathing. My lungs were starting to fill up. The doctor still didn't have an idea of what was wrong with me. Just thought it was a really strong flu at that time. My lungs started to fill up with mucus and I started to come down with pneumonia symptoms. About nine o'clock that night I could hardly breathe at all. And I remember pushing the button for the nurse and then everybody came...and then not remembering anything after that until I was on the ambulance on the way to the U of A. I remember what it felt like...I was on my side in the ambulance, and it felt like it was crushing my chest. Whether that was because my lungs were full or because it somehow shifted the mucus in it or whatever...but I remember it being very painful in my chest on the way to city. And once I got to the city I went to the emergency room and for some reason I seemed to feel better at that time. They gave me an intravenous and a catheter. I steadily got worse so they increased my oxygen level. Or they tried to...to the point where they had to put me in intensive care, pediatric intensive care. Once I did go into ICU they were very afraid. And my family was told that I was going to die and it was really hard on my family, on my church, and on my community. I remember a lot of people pulling together and praying for me. And supporting my family through gifts of time and cards and even money sometimes. Yeah, it was quite heart warming actually, the way a lot of the people gave their time and their money.

I believe I was there Tuesday afternoon to Wednesday afternoon. During that time they tried all sorts of different kinds of things. They monitored my heart rate and pulse and everything very closely. They put a stomach tube to pump my stomach out kind of like a last resource. My lungs by that time were over 80% full of mucus or fluid. After...a couple of hours after they stomach pumped me I started to feel a little bit better and the next day I was ready to go out of ICU. And after that I rapidly recovered. I gained strength. I could move by myself, although not very well. I still had dizziness to a certain extent but it rapidly went away. After that they discharged me that Friday, I believe it was. And I went home and sat around the couch for a while. And by the next week I was back playing baseball. Not very well, obviously. I was weak for about four to six weeks afterwards before I gained most of my strength back and muscle tissue. So yeah! I wasn't really back to normal. But eventually I did become back to normal. I could do anything anyone else could within four to six weeks. I do remember I did have a slight shortness of breath for quite a while afterwards. But it didn't really affect me in day to day activities.

I was told I was immune and I just wanted to put it behind me, actually, for a little bit. Just that, it was pretty much a bad memory for the most part. I'd never experienced that kind of pain before. Just facing death itself was scary and awful sobering. It just wasn't a good memory at the time. I remember I couldn't talk about, my family couldn't talk about it without tears in their eyes. So...told I was immune. So, for a while I had a good satisfaction of killing mice so I went out and killed mice for a while. And took either my gun or my hockey stick and did a little damage. It was a little bit of payback." (FA 21)

After his experience this farmer took some precautionary measures such as wetting down an area before cleaning it up. However, he does not wear a mask or gloves. He

was told that he was most likely immune to that particular strain of the disease, and therefore the likelihood of him getting it again are fairly small.

The Experiences of Farmer 25

This farmer was in his mid to late 50s when he contracted hantavirus. Some of his physical symptoms are different from the other two farmers. He recalled watching documentaries on hantavirus prior to becoming ill.

"I'm a farmer and I operate a tractor. And I guess these mice they'll nest inside, they'll go right into the cab where you have the air conditioning and the fan that blows air into the cab. It forces air into the cab. And what happened, they got up there and they made some nests. And, although I knew that before the spring. I cleaned the nest out and stuff, but what I should have done. I could smell it. I could smell the mice feces. And I should have disinfected it. But anyway, I put up with it and worked with it. In the spring you haven't got time to start disinfecting. So I was breathing this in. And about the same time I did grab a mouse to clean the area. I got it with my hand. And somehow I was not quick enough and she bit me. So, I had the two things that happened at the same time. So I don't know if it was the bite or breathing in the airborne dust from the nest, you see. But I got both.

Then within a couple weeks after that I got sick. It was like a flu. And what happened it was on a Sunday we had been playing sports. And we were running and playing tag. And we played for about half an hour. I was always kind of an athletic person. And I got cramps in my legs and these cramps would not go away. So I quit playing. And then the next day I started to have fever and the cramps were still in my leg. And I was getting a fever like a normal flu. But I got worse. Like I got feverish and more feverish. And then the next day I figure well I'll get over it. But I wasn't. I just lost my appetite. Yeah Monday I started to get the flu and started to feel feverish. Tuesday was worse. Rather than go down it was worse. But I didn't know what it was. Really I was hoping it would get better. So Friday...I had to put up with it until Friday. Then I went to see the doctor. And he says to me, 'Oh you have the flu, there's nothing we can do about it. You've got to fight it on your own.' Then I came back home from the doctor on the Friday and I got thinking, you know. It just so happened that I had seen two interviews about that on TV. And then I got thinking about these mice. So I phoned another...my regular doctor and I told him. So he said, 'you better come in.' And I'm 50 miles from the hospital. So I went in on the Monday.

So now a whole week has gone by and I went into the hospital on Monday. And they put me in the hospital right away and they put me on some intravenous and antibiotics. But they checked my oxygen and they said that it was awfully low. I never even realised that although I was sick. And I had a throbbing headache. Just short spans of headache. I would have a headache and then it would go away. So it was kind of a pain. A quick pain and then it would go away. So the doctor phoned Edmonton and they right away flew me there and they looked

after me there. If I had waited another day or two I don't think I would have made it.

I never noticed the shortness of breath. I never even noticed the pain in the chest or nothing. Or in my lungs or whatever. But I had no appetite. I just didn't want to eat anything. It took two months to get my strength back. Like the first week or two weeks I would go outside and work maybe an hour and then come back inside and lay down for a couple of hours. I didn't have the strength you know. I felt weak. And then I got a little stronger. It took two months and I was able to work. We had the two jobs here. We had a farm and also we had a mechanics shop. I quit the shop because it was a lot of physical work there." (FA 25)

This farmer does take a number of precautionary measures such as wearing a mask if he is going to be working around mice. He was uncertain as to whether or not he can get the virus again.

Assessing One's Exposures

One of the three main categories that emerged from the data, and contributes to this conceptual framework, is assessing one's exposures. Two categories that constitute this main category are potential exposures, and affiliation with cases.

A. Potential Exposures of Farmers and Forest Professionals

One of the important categories of this conceptual framework is an understanding of the potential exposures of farmers and forest professionals.

Identifying the potential exposures

Table 4-4 exemplifies the potential exposures that were identified by farmers and forest professionals.

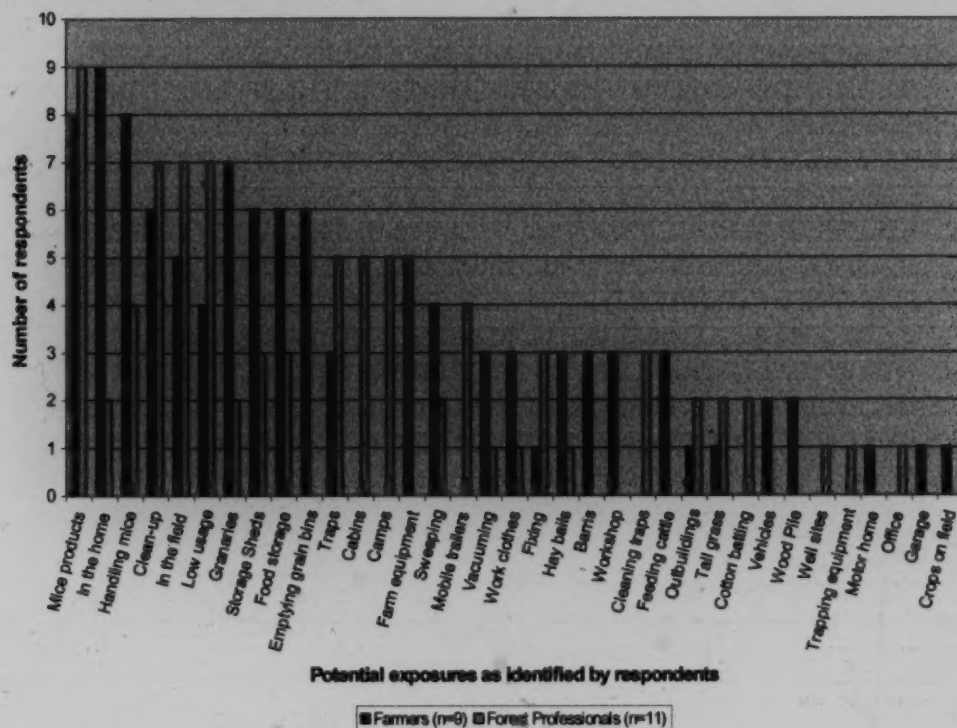
Table 4-4. Identifying the potential exposures

POTENTIAL EXPOSURES				
Occupational Activities	Clothing and Equipment	Structures (permanent vs. temporary)	Degree of enclosure (open vs. enclosed)	Mouse habitat and detritus
Handling mice	Traps	<i>Permanent structures:</i>	<i>Enclosed:</i>	Mouse nests
Cleaning traps	Cotton batting for traps	Granaries	Granaries	Mouse excreta
Emptying grain bins	Trapping equipment	Storage sheds	Storage sheds	Hay bails
Feeding cattle	Farm equipment (e.g. tractors and seed drills)	Food storage bins	Food storage bins	Wood piles
Working on crops in the field	Vehicles (e.g. in the cars and work trucks)	Cabins	Buildings, equipment and vehicles that are rarely used (low usage)	Buildings and structures
Clean-up activities	Work clothes	Barns	Workshop	Equipment
Vacuuming		Workshop	Outbuildings	
Sweeping		Outbuildings	Cabins	
Fixing		Office	<i>Open:</i>	
		Garage	In the "field" (e.g. in a forest or a farmers field)	
		Well sites		
		House		
		<i>Temporary structures:</i>		
		Mobile trailers		
		Camps		
		Motor home		

Figure 4-5 provides a comprehensive list of potential exposures to deer mice, their nests, and their excreta and shows the frequencies identified by farmers and forest professionals.

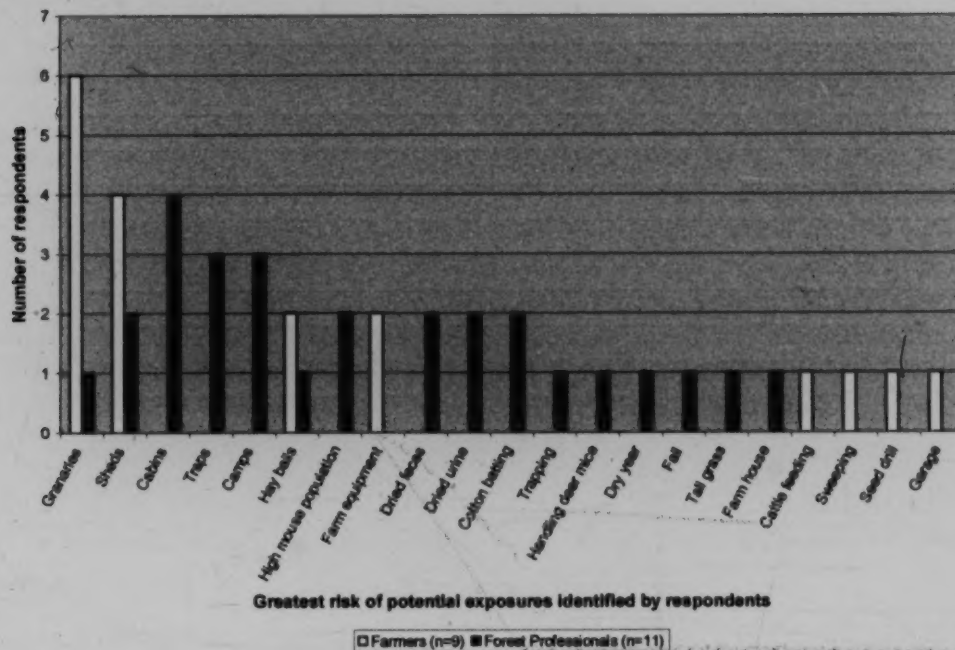
Forest professionals most often identified exposure to deer mice and their products (i.e. their nests, and excreta) as occurring while working in the field and in places that have been abandoned or are of low usage. Clean-up activities were another risk factor. However, farmers most often identified exposure to deer mice and their products, occurring in the home and in granaries, and while handling mice. Additional factors are identified in Figure 4-5.

Figure 4-5. Comprehensive list and frequency of potential exposures as identified by farmers and forest professionals



Farmers and forest professionals were also asked to identify which occupational tasks or work sites had the greatest risk of exposures, illustrated in Figure 4-6. Farmers identified granaries and sheds, such as work or storage sheds as the two main areas they perceived as their greatest risk of exposure. Hay bails and farm equipment were also considered areas of high risk. Forest professionals cited cabins, traps and base camps as the three main areas of greatest potential exposures.

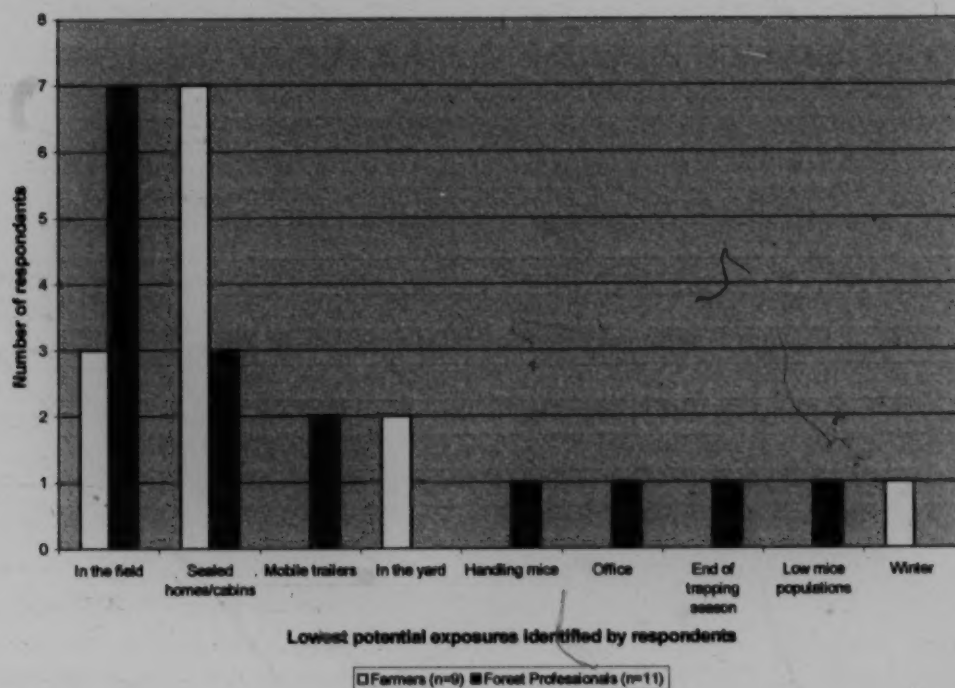
Figure 4-6. Perceived greatest risk of potential exposure



Farmers identified specific work sites and equipment as areas of their greatest potential risk of exposure, whereas, forest professionals identified equipment (i.e. their traps) and their living quarters while in field camps, as the greatest potential risk of exposure.

Farmers stated being in a sealed home or cabin had the lowest potential risk of exposure, whereas forest professionals identified being out in the field, for example walking in a forest, as their lowest potential risk of exposure. Figure 4-7 illustrates the frequencies of all items listed as the lowest potential risk of exposure.

Figure 4-7. Perceived lowest risk of exposure



Areas of high risk appear to be reversed for both groups in terms of their perception of their greatest or lowest risks of potential exposures. Farmers see their greatest risk to be in various buildings or structures in their working environment, and they see structures of their non-work environment to be the lowest potential exposures. However, forest professionals see their non-work environments (e.g. base camps) while in the field as their greatest risk of exposure, but their actual working environment as their lowest risk of exposure.

Categories of Potential Exposures

Four main categories emerged from the data as the main components of farmers and forest professionals' potential exposures: level of exposure to deer mice and their products; degree of enclosure; level of dust in the environment; and periodicity of usage.

1. Level of exposure to deer mice and their products: Presence /absence

Farmers and forest professionals determined the level of potential exposure in the context of the presence/absence of deer mice, their nests, and their excreta. For both, the presence/absence of mice was one of the main factors that influenced their decision concerning the use of precautionary measures.

Both groups defined the presence of mice as a visual assessment of deer mice, and their detritus. Some respondents described recognising the presence of mice by their smell, which they said had a "very distinctive odour":

"You do think about hantavirus when you smell the mice. And you wonder if it could cause you a problem." (FA 23)

Low Level of Exposure

In general, it was forest professionals, not farmers, who suggested that they rarely saw deer mice when performing occupational tasks.

"Most of the small mammal stuff we have done probably in the past six or seven years, the number of deer mice we've caught has been so low, it's probably not worth worrying about it. Most of it is in undisturbed forested habitat and probably deer mice are only about 2% of what we catch. Maybe. And in fact, in some of the stuff we've done, we've never caught a deer mouse. So I don't. I'm personally not too concerned about it." (FP 4)

The lack of first hand observation of mice leads to a lack of concern regarding hantavirus resulting in the low, or non-practice of precautionary measures.

"If you don't see dust or droppings then you're not concerned about taking the measures. If I don't see the physical signs of the presence of mice (mice, mice feces, nests) then I'm not so concerned about taking preventive measures." (FP 2)

Generally, some farmers and forest professionals felt that if you did not see or smell mice, or their detritus, then one did not need to take any precautions. That is, they would take a chance, in the assumption that the virus was absent and their health was not endangered.

Moderate to high level of risk

Farmers generally felt that their risk was moderate to high, because many said that mice were present throughout their farm. It was not uncommon for them to see or smell mice and observe their detritus on a regular basis. As a result, farmers had a higher potential exposure than forest professionals. Some forest professionals mentioned that it was farmers who should be more concerned with hantavirus, because they felt that farmers were more likely to come in contact with deer mice and their detritus.

For those who felt that deer mice were everywhere and were unavoidable, they tended to feel a sense of helplessness and lack of control in terms of being able to eradicate or avoid the mice. It was a part of their job that they would simply have to accept.

Exceptions

There is an exception to this idea of low exposure leading to lower level of concern and perception of risk, and higher exposure leading to a higher level of concern and perception of risk. Some farmers and forest professionals felt that deer mice posed a low risk, because they were commonly observed and encountered. That is, either they had handled them as children, or they handled them as part of their job tasks. Despite this high exposure to the SNV vector without taking any precautionary measures, they did not get hantavirus. These individuals, although they had a high exposure to deer mice, they felt their risk of getting hantavirus was very low.

"When there have been people who have been handling them for years, like 10 or 15 years. It's ridiculous. I've handled so many of these mice and I've never gotten hantavirus. I really don't think it's a big issue." (FP 19)

Another forest professional expressed a similar sentiment.

"I think if anybody was going to get hantavirus, I would probably have been a good candidate when I was younger because we use to handle thousands of small mammals. When I started biology which was a long time ago now. We had two studies on the go. One where we trapped three months a year and one where we trapped two months a year. And that I did for two or three years. And the one where we trapped three months a year carried on for another couple of years. So, I would have imagined that at that time I would have handled a couple of thousand of mice. So, if I got sick I don't remember it. It wasn't significant...It wasn't a significant event in my life." (FP 4)

One forest professional explained this phenomenon as becoming very familiar with the circumstances. That is, as one becomes familiar with something they know what to expect and, therefore, they become less concerned.

"And like with anything else, when you start becoming use to something or you're in contact with something, it becomes less terrifying and less scary." (FP 11)

Therefore, continuous encounters with the mice lead to a feeling of invulnerability to the virus. Some farmers and forest professionals expressed this. One farmer who contracted hantavirus described this familiarity concept in terms of his perception of hantavirus and exposure to deer mice, prior to contracting the disease.

"It was something I had done many times before. The same old thing. Just sweeping out granaries. That was something that I had done many times before. So I wasn't going to be too concerned about it. That's changed now." (FA 16)

This farmer also made a comment regarding his perspective on why some people who seem to come in contact with deer mice do not contract HPS. Two other farmers also expressed this concept.

"Everybody can get exposed to it but not everybody will catch it. I don't know why. I don't think anybody knows why." (FA 16)

His perception is one of uncertainty; that is, it is something out of his control and he has no understanding of why this is so. This uncertainty leads to a sense of lack of control in his environment.

Some farmers and forest professionals perception of risk is so great that they do not think it is necessary to take any precautions, because it is something that is out of their control anyway. However, others felt that taking precautionary measures was the only way that they could gain a sense of control in an environment where they did not feel that they had any control. They trusted that being able to take precautions would in fact reduce their risk of exposure.

Prioritising Risks: A comparison to other occupational risks

For some farmers and forest professionals their exposure to deer mice and their detritus was a much lower priority compared to other occupational health and safety issues they encounter on a daily basis.

"There's a lot more of a danger than hantavirus... In the scheme of things it's a less of a concern than these other things like bears, blow down of trees, forestry operations, logging equipment, and logging trucks." (FP 3)

They rationalised their behaviour regarding hantavirus lowering their level of concern. They felt that there were so many occupational hazards they could be exposed to, they could not be concerned about everything. Thus, if they perceived their exposure to be low then they were not going to be very concerned about hantavirus and taking precautionary measures. They felt that they had some level of control over this decision, because their exposure was low and it was not something they needed to be concerned about. However, they did acknowledge that if they were certain that they were going to be exposed to deer mice or their detritus then they would take the necessary precautions to lower their exposure.

"If I'm doing certain things then I think about it. Such as if I'm in the trapper's cabin or in a farmers granary...and I'm going to be mucking around in there, stirring the dust up, doing whatever, then yes I will wear a dust mask" (FP 9)

Uncertainties in Exposure

Although these groups suggested they would take a chance and not take any precautions if they felt mice were not present, one of the main uncertainties that appeared to give these groups a feeling of lack of control was the involuntary nature of their exposure. For some this meant that those situations or encounters that were unexpected were the ones that concerned them the most. To avoid this unprepared exposure they would take some precautions whenever they were doing activities where they could potentially be exposed. This made them feel that they had greater control over their situation.

However, others felt that the potential exposure to hantavirus was inevitably a part of their job, it was just a risk they would have to take. In rationalising this attitude they would opt to taking little or no precautionary measures, because they believed they had

no control over their chance of exposure. Therefore, their potential exposure to deer mice and their detritus were considered unavoidable.

ii. Level of enclosure: Open vs. enclosed spaces

The main concept behind the exposure of these two groups and their perception of risk is whether the environment in which they work in is an enclosed versus an open space. Some forest professionals, such as those who were handling deer mice, felt that their occupational risk of exposure was low because they were in an open environment.

"And I think the risk is very low of actually contracting it. And I do not feel that I was working under conditions that would be a high risk. Like for example I was working outdoors." (FP 19)

A trapper and wildlife biologist mentioned that even though they were handling traps, this was being done in an open environment and as a result their potential for exposure was lower.

"If you're outside and everything is blowing around then you're not so much at risk. But it's when you're in a confined space, like a building, then you're probably more at a risk." (FP 2)

A forest professional described a situation she would avoid, because of the nature of being in an enclosed environment and increased likelihood of becoming exposed.

"But I would not for example go sleep in the back of the truck...within a closed. I would not hang out or sleep in an area, an enclosed area. Particularly in a very small one that had been dried out or where traps had been dried out or where traps had been stored. Or has a healthy community of deer mice in it." (FP 19)

iii. Level of dust in the environment: Wet versus dusty environments

The level of dust in the environment was identified as another risk factor for forest professionals and farmers. One forest professional who handled mice felt that if the environment were wet then this would lower the amount of dust in the environment.

"If I was handling feces or coming into contact with it, it was moist and wet. There wasn't much of a chance that I would be inhaling anything. I guess the other one was that I wasn't living in conditions where I was being exposed to a lot of dry feces that were being stirred up into the air. Oh, and the other thing is that

the environment is very wet. So if I remember correctly, most of the cases in British Columbia, were in the interior where it's very dry. And so it's more likely that the feces are going to dry out and you're going to have more particulates flying through the air. And I just didn't feel that I was going to have that kind of exposure." (FP 19)

Some farmers, however, suggested that their potential exposure was greater because the environments in which they work are relatively dusty.

iv. Periodicity of usage

Forest professionals and farmers described situations of low and high periods of use in areas where mice could inhabit. Areas of low usage could be structures that were temporary or permanent, and areas that are not frequented as much, therefore, allowing mice to inhabit and go unnoticed.

Forest professionals most frequently talked about their exposures in their working conditions related to whether their living or work structures, such as tents, trailers, cabins, and motel, were temporary or permanent. That is, they felt that if they were living in temporary structures like trailers, especially if they were moving from one place to the next in relatively short periods of time, then there was little chance for mice to inhabit these trailers. Therefore, a lower risk of exposure was perceived.

"As for the truck campers, well we are constantly moving so there isn't really any time for mice to infest these campers." (FP 2)

However, if they were living in camps that had been established for many years, then there was more of a chance for mice to inhabit these living spaces. Therefore, a higher risk of exposure was perceived.

"The only time I've ever seen one close up was when we were living in those trailers on site that were permanently there on the ground. That was the only time I've ever really come across them myself." (FP 3)

Farmers described the length of time that a piece of farm equipment or a structure had been abandoned as the time within which mice were able to establish nests in their equipment, such as grain trucks, or structures, such as granaries. These equipment and structures are often left abandoned for months and used only at certain times.

"A grain truck is what all farmers have. It's a great big box on a bigger truck, on the back end. And they haul their grain from the fields to the granaries, or from the granaries to the elevators. And these mice for some reason are another haven for them because these trucks we don't use them a lot. They sit there for the rest of the time. And somehow they come in there and they get inside. And they nest in the heaters, where the heaters and fans are a nice little homey place for them. And then when you start your truck and you start your heaters it blows the dust through the heater vents and defrost vents and all that. And that's all airborne stuff. So, that's where you don't have control." (FA 25)

Due to the long period of disuse there is more opportunity for mice habitation. As a result, the potential risk for exposure is higher.

B. Affiliation with Cases

The affiliation with cases is another major factor influencing the decision making process to take precautionary measures. This affiliation is based on three components: the geographic proximity to cases, the level of personal connection with the cases, and identifying with the victim.

Affiliation with cases is defined on three levels: primary, secondary, and tertiary. These levels are based on geographic proximity to the cases. The primary level is a case that occurred within a community that the interviewed person lived. For purposes of this study a community is a county: a spatial geographic reference point. The next level is the secondary level, where the case would have occurred in a neighbouring community. At the tertiary level, the case would have occurred in a community beyond a neighbouring community. Respondents may have either known the cases personally, or heard about them from other people, or through the media. In addition, respondents may or may not have identified with the hantavirus victim. This depended on whether or not they related to the victim in terms of performing similar tasks, or if they could identify with the victim, because they had children or other close family members who were a similar age, performing similar tasks.

The interconnection between these three components is that a case that occurred within a community could have been a neighbour or a friend. Thus, the respondent had a personal affiliation with this case.

"A farmer is not going to pay any attention unless it's something that has happened that's close to them or is valid to their life at that time. I know people around here wouldn't really care about hantavirus unless people had not come down with the illness here." (FA 21)

There is also a personal identification with the victim through a shared geographic region. The assumption is that if a neighbour or someone in their community came in contact with infected mice, they could as well.

"People getting ill. People getting sick and dying. And more so closer to home here. And you hear about it and you keep it in the back of your mind. But now that it has happened to...where a person within I would say, 30 miles of my home here has died from it. And another person within 20 miles was diagnosed with it and was in the hospital critical with it and did survive. That you think more about how it can happen and what you can do. And that's about the only awareness we know of it. That is, what we have heard and talking to this other person that was in contact and was very sick." (FA 23)

The respondent or their family members may have also been undertaking the same tasks as the victim on a regular basis. Therefore, they are not considered unfamiliar or risky tasks.

"Oh yeah. Because the young fellow that died was only 16 or 17 or something like that. Because my children were all teenagers at that time too. So, we pointed out to them that this could be a problem not to think that mice were something that you didn't have to worry about. Because, basically up to that point a mouse was just a pest it wasn't something that could cause death to us. I mean we never use to think about it that way." (FA 10)

However, if the case occurred in a neighbouring community there was varying levels of personal connection. That is, the respondent could have personally known the victim or heard about this individual from others or through the media. If they knew the person then their perception of their risk of contracting HPS was greater than if they did not. For some there is the assumption that there is the possibility of infected mice in the region. Thus, their level of control in knowing which mice may or may not be infected is low, therefore their perception of their risk higher. For others who may not have had a personal connection with the victim, there may still be an issue of close proximity to an infected mouse population, or they may have been doing a similar task as the hantavirus victim.

If an HPS case was in a community beyond a neighbouring community, then more than likely the respondent would have heard about the hantavirus victim, rather than personally known them. Although, there is less or no fear of being exposed to an infected mouse population that the hantavirus victim may have been exposed to, there may be some affiliation with similar tasks that were carried out by the hantavirus victim. However, those who did not do similar tasks as the hantavirus victim had a lower perception of risk compared to those who suggested that they did similar tasks.

Dealing with Their Potential Exposures

The third main category in this conceptual framework is how farmers and forest professionals dealt with their potential exposures. Their perceived level of exposure influenced the context within which they considered ways of dealing with their potential exposures. Experience with precautionary measures affected their perception of their risk. The physical factors of their working conditions affected how they dealt with their level of exposure.

A. Experiences with Precautionary Measures

Farmers and forest professionals were asked about their experiences using precautionary measures, if they took any measures at all. Both farmers and forest professionals identified a variety of precautionary measures, and described their experiences using these measures.

Description of the Precautionary Measures Taken

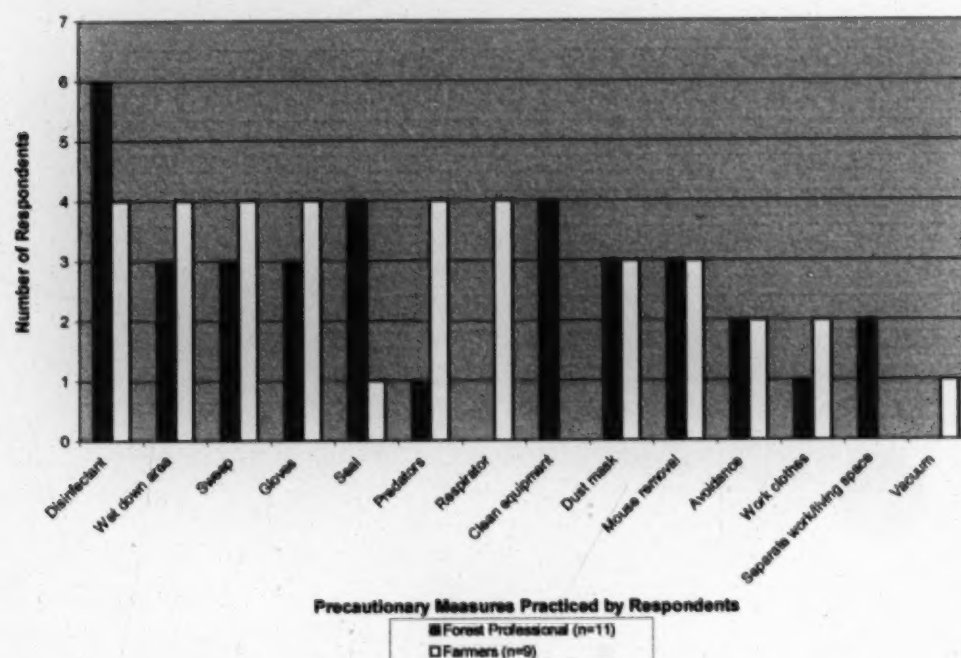
The precautionary measures identified by farmers and forest professionals were grouped into two main categories; safety equipment and precautionary actions. Table 4-5 lists the methods employed by these two groups.

Table 4-5. Groups and examples of the precautionary measures taken by farmers and forest professionals.

Precautionary Measures Taken	
<i>Safety Equipment</i>	<i>Precautionary Actions</i>
Use gloves	Use a disinfectant
Use some type of respirator	Wet down the area
Wear a dust mask	Sweep the area
Wear work clothing (e.g. coveralls)	Seal the structure (e.g. buildings, cabins)
Separate work and living spaces	Clean equipment
	Keep predators
	Remove deer mice, their nests, and excreta
	Avoid deer mice, their nests, and excreta
	Vacuum

The following figure (Figure 4-8) shows the frequency of the methods identified for the precautionary measures taken. A break down for forest professionals and farmers is also provided.

Figure 4-8. Prevention Practices taken by Respondents



When we compare this list to those identified by farmers and forest professionals when they described their knowledge of the precautionary measures, we find that there are differences. Both groups recalled a few more methods as compared to what they actually did. Therefore, it may be concluded that the methods they actually use are ones that are more practical to their work situations.

Reasons for Taking Precautionary Measures

Forest professionals and farmers alike said that they took precautionary measures because they felt confident that in so doing they would reduce their exposure to the virus and they would be able to avoid any unexpected encounters with deer mice.

Although one forest professional thought they were "cute" creatures, he also said that these small mammals could be "deadly". Essentially the concern expressed by some farmers and forest professionals was how a creature that was this small and common could cause one harm. Another forest professional described a reason to get rid of the mice, because their excreta would get all over the counters and in the cupboards in

some of the cabins he recalled staying in. He described his primary motivations for action to clean up, because the mice excreta were "gross and a part of it was that there is some concern over hantavirus" (FP 15). Farmers expressed a similar dislike for deer mice and suggested this was their motivation to get rid of them.

"We just dislike mice so much that it's just something that we've been always concerned about, being in the areas where they have been. But we feel the main thing is to use precautions to try and avoid the problem of them." (FA 18)

Even those forest professionals who were handling mice still took some measure of precaution; such as wearing gloves when they were handling mice. Wearing gloves served a dual purpose: in case one had cuts on their hand they would not get exposed to the virus, as well as to protect from getting bitten by the mice.

Two farmers described a similar process they took when deciding whether or not to take precautionary measures, such as wearing a mask and gloves, prior to entering a closed, airtight workspace.

"Like for example, if I go to climb in a combine. I don't just shove right in. Just survey the scene and see what's up before you go opening the door. Like if you don't see a bunch of mice feces or stuff on the floor. Then that's pretty good indication that there's nothing there. But as soon as you see a bunch of nests, well get on the proper protection before you enter. The problem with that is that everything has been closed up for so long and everything is airtight. So as soon as you open, woof you get a big blast of it. That's a big thing." (FA 16)

One respondent did not take preventive measures while out in the field for the following reasons:

"Because contact in the field is zero or reduced to low levels of exposure. We don't work with deer mice so our contact with them is very low. Everyday practice we don't see mice. And we are normally living in truck campers, motels or hotels. We have not seen any mice around in the areas where we are living when we are out in the field. As for the truck campers, we are constantly moving so there isn't any time for mice to infest these campers." (FP 2)

Barriers to Taking Precautionary Measures

This category emerged when both farmers and forest professionals identified a number of barriers they faced in taking precautionary measures. This category is comprised of a number of sub-categories: the effectiveness of the precautionary measures, lack of preparedness, and practicality of taking the recommended precautionary measures.

i. Effectiveness of Precautionary Measures

It was forest professionals who raised the issue of whether taking the recommended precautionary measures was actually effective in preventing an individual from contracting the virus. They did not trust the information provided and questioned the efficacy of taking certain precautionary measures.

At the time when one forest professional was working in field conditions where he was handling deer mice, there were a number of people on the crew wearing dust masks. These were essentially masks that one could buy at a hardware store to use for dry walling or painting. However, this forest professional did not use the dust masks because:

"I Didn't think it could stop the virus... Besides you couldn't really keep it clean, because you could put it in a pocket that had feces or urine particles in it and therefore inoculate yourself. So, the dust mask was more of a hazard." (FP 1)

Another forest professional described an experience where their work shed out in their bush camp was infested with mice. He was uncertain about the use of lab alcohol as a precautionary measure.

"I Could have used lab alcohol. But how effective would that have been?" (FP 3)

A third forest professional who also had some limited exposure to deer mice in the field, while working on various mammal projects, was uncertain about the use of dust masks and rubber gloves:

"Wearing dust masks and rubber gloves might help. I don't think that there is any strong evidence to suggest that they do." (FP 4)

ii. Lack of Preparedness

Some forest professionals and farmers said that they did not take precautionary measures, or some level of precautionary measure if the equipment was not available at the time they needed it. As a result they were not prepared to deal with a situation where they were exposed to deer mice and their detritus.

One forest professional that worked in northern Alberta described his experience of not being prepared when they had an infestation of mice in their work shed. In this case they were unprepared, not due to a lack of resources, but rather because they did not think that they would have to deal with a situation of deer mice exposure.

"If you know you're going to be dealing with it, sure you can always wear dust masks and stuff. I mean there's no reason not to. And you know you can always wear gloves and that kind of thing. But because we don't deal with it directly we don't have that kind of stuff with us. We don't think about it so we don't use it, kind of thing. When we were staying up in [northern Alberta] we were totally unprepared. I'll be forthright about that... We weren't prepared for it then. I had never had that problem before then, so we weren't really prepared for it. Generally most of the time we probably have a lot of control over it because we don't ever deal with it or we rarely have any dealings with mice." (FP 3)

A farmer described not being prepared because he did not keep the equipment in a place he could access when he needed it.

"Well that would be just plain having to do something and haven't got ones equipment or face mask." (FA 18)

As a result of not being prepared to deal with a situation where there might be potential exposure, these individuals felt that they had less control over their situation, that there was nothing they could do about their situation, because they were not prepared for it. This unexpected exposure led them to feeling less in control and uncertain as to whether or not they could have been exposed during that experience.

iii. Practicality of the Precautionary Measures

There were a number of barriers identified with the practicality of being able to use certain precautionary measures while performing work tasks. Farmers and forest professionals alike identified these barriers.

One forest professional described just how hot and uncomfortable it was to use the recommended HEPA filter masks while working in the forest.

"HEPA masks were designed for someone who did not have to wear them 8 hours a day in field conditions. I saw one colleague wearing it and he was sweating so much it was coming out of the respirator hole." (FP 1)

Both FP 1 and 4 said that wearing a dust mask fogged up their glasses and the gloves made it difficult to handle the animals. The majority of farmers and forest professionals expressed concern over the practicality of using the current recommended preventive measures.

"The precautions we try to take with people who work with us is using dust masks and rubber gloves when handling wild rodents. In practice, that's hard to do and most of them don't do it. I don't do it. (Laughs). Probably, if I wear a dusk mask my glasses fog up and I just can't handle, for whatever reason, I just can't handle animals with gloves on. If I wear gloves I just can't handle the animals, or get my fingers caught in the trap, or tag my thumb or something." (FP 4)

Farmers and forest professionals both identified the impracticality of using some of the recommended precautionary measures such as masks, gloves, and goggles.

B. Physical Factors of the Working Condition

Physical factors of the working condition were another category that emerged from the data. Properties that made up this category are perception of physical health, level of physical energy, and the amount of time available to complete job tasks. This category and its properties contributed to how the farmer or forest professional dealt with their level of exposure; that is, the physical factor contributed to determining whether or not one took precautionary measures.

Perception of physical health

The importance of physical health to farmers and forest professionals was in the context of their potential or actual exposures to deer mice and their detritus; that is, they talked about perceptions of their physical health in terms of their exposures. Conditions that influenced this phenomenon are age and perceptions of their general health. The

perception is those who are younger are more likely to be healthier and more resistant to infections than an older person. The younger, healthier individual is assumed to have a stronger immune system, which gives them some level of "internal" protection against diseases such as hantavirus. Only farmers mentioned this concept of age.

One farmer (FA 23) said he knew someone who had contracted hantavirus and survived. His personal contact was FA 21, who was also interviewed for this project. FA 23 said that he knew FA 21, because they lived in neighbouring communities and knew this farmers parents. FA 23 said that at time that FA 21 contracted hantavirus he was just aware that someone in the community had this disease. He also knew that FA 21 was ill, but did not realise that he was the one who had hantavirus. When he later realised that it was in fact FA 21 who had hantavirus he was quite surprised. He described this discovery as an "eye-opening experience". He was surprised, because he knew that at the time FA 21 had contracted hantavirus he was in very good physical fitness. He talked about FA 21's involvement in volleyball and hockey. At the time, he appeared to be very healthy because of his physical fitness. It was a surprise to find out that someone so young and healthy could actually become so sick.

"That was quite an eye opener talking to him. And he is quite young. You would think younger people would be able to ward it off a little bit better. But...and he's in good shape." (FA 23)

When FA 21 was interviewed he described that at the time just prior to contracting hantavirus he was very active and "fairly in shape". He was very surprised when he got sick, because he was so healthy at the time. The other two farmers who contracted hantavirus also expressed a similar feeling. They too were surprised, because at the time they also felt they were in good physical health.

"I mean how could a guy come down with that thing. And I was healthy. At least I thought I was healthy. I didn't even smoke. I was 32 years old at the time."
(FA 16)

Therefore, for these farmers to find out that one could contract the virus even though you were young and healthy, caused them some level of concern. Their perception of who was most at risk of contracting the virus was changed by their experiences. What they once thought was a factor in protecting themselves from illness or infections no longer

appeared to hold true. Assuming that youth and good health was an effective mechanism against diseases was no longer seen as guaranteed protection against hantavirus. Thus, other measures would have to be taken if one was concerned about contracting hantavirus.

Another farmer (FA 10) said that in their community a number of the older farmers were concerned about getting hantavirus, because they felt that at their age their immune systems were not strong enough to fight off infection. For these farmers there was some level of concern for hantavirus exposure and contracting the disease. This farmer also said that the younger farmers in their community were not as concerned about hantavirus as the older farmers.

However, a forest professional (FP 19) maintained that a strong immune system could be a good protective mechanism. For this forest professional ensuring that one had a good nutritional diet was a way to maintain a strong immune system. Therefore, the perception was that a strong immune system provided some level of control over infections or viruses like hantavirus.

Level of physical energy

Another factor identified as a physical factor of the working condition was the level of physical energy. In this study, the word "energy" can be defined as the capacity for action. Thus, the level of physical energy is the physical capacity of a farmer or forest professional to perform their job tasks. Their level of physical energy was dependent upon the length of time that one had been working; that is, the longer one had been working the more tired or fatigued they became and the less physical energy they had. As a result, they were too tired to take precautionary measures a priority. There were three forest professionals and four farmers who described this phenomenon.

Two wildlife biologists provided similar scenarios about working out in the field. Typically, field projects run with a work schedule of ten days on and then four days off. The two biologists talked about when one initially goes out into the field one's energy levels are high. With these high energy levels they are motivated to accomplish job tasks and perform these tasks safely. One wildlife biologist (FA 1) described the first few days back on the field as a time when energy levels were still high. At this time, he

would take a few more protective precautions such as, taking more time to maintain a clean hygienic living environment; scrupulously cleaning up food remains in the cook tent so that mice would be less attracted to this area; and keeping work clothes and trapping equipment as separate as possible from his living environment. However, as more time passed in the field the level of physical energy declined and so did his motivation to take precautionary measures. As this wildlife biologist said:

"Mostly when you were tired, you weren't bothered about taking preventive measures." (FP 1)

The longer this wildlife biologist was in the field the more tired he became and the less meticulous he was about keeping his working and living "environments" separate and hygienic. Clothes would not be sprayed off very thoroughly with alcohol; clothes and work note books which were carried around in the field, and on which mice were placed while he collected data, were taken to the cook tent. Sometimes data entry was done while eating, as a means of accomplishing two tasks at once. Thus, the more fatigued he became working in the field, the less effort he made in separating their living and working spaces. This phenomenon was described by two other forest professionals.

And another wildlife biologist said:

"And after a long day sometimes you would not put the effort into keeping the place as spotless and you normally would". (FP 15)

As a result, while the level of concern remained high the fatigue factor reduced the diligence regarding protective measures. It was apparent that as they became more tired in the field these people had less energy to take precautions. Therefore, the level of concern did not change, but rather their level of energy to perform tasks did.

Amount of time available

Another factor identified as a component of physical factors of the work environment was the amount of time available. This factor was to some degree related to the level of physical energy. Farmers and forest professionals, such as trappers and wildlife biologists, both described this as an issue, particularly in the months from March/April to October/November when they were working out in the field. The priority was to

complete tasks within a constrained time budget. When these groups were "fighting against time" to do this, taking precautionary measures became less of a priority.

"And if you've got to live trap then that means that you've got to constantly be checking your traps. And that eats up your time. And if you've got kill traps, you've still got to check them. So, just too busy and don't have the time." (FP 11)

Thus, for some farmers and forest professionals they described spring, summer, and fall months as times when they are relatively busy in trying to complete job tasks.

Gauging the Level of Precautionary Action: The central category

The central category identified in this theoretical framework is gauging the level of precautionary action to take. There were four levels of precautionary actions identified: no, little, moderate, and high. There were two respondents, both forest professionals who took no precautionary measures. One of them did not take any precautionary measures because he did not recall seeing any mice or their detritus while he was working in the forest and other outdoor environment, or in their living conditions while working in various field sites in northern Alberta. Thus, because he felt he did not have any occupational exposures to deer mice or their detritus he had not taken any precautionary measures while working. The other forest professional did not take any precautionary measures because he found that they were not practical in the field. He also questioned the efficacy of taking some of these measures. In addition his perception was that hantavirus was a rare and random disease and therefore he was willing to take his chances on not taking any precautionary measures.

There were other farmers and forest professionals who took no precautionary measures at times when they did not think they would encounter any mice. Even those who perceived their risk to be relatively low took one or two precautionary measures such as wearing gloves, or using a bleach solution to wash down an area, or wearing a mask. In general those who were not too concerned about hantavirus, but concerned enough to do something were more inclined to use a dust mask as opposed to using the recommended mask such as a HEPA filter mask or an N-100, R-100 or P-100 type mask. Those who took moderate levels of precautionary measures took as many precautions as they could. They tended to use the recommended type of mask. And

the use of a mask was generally one of the precautions they would take; however this was not always the case. For example, a forest professional who felt that being in the open environment reduced his/her level of exposure was less inclined to wear a mask. However, they would take other measures like wearing gloves, keeping living and working environments separate, wearing work clothes, disinfecting equipment with lab alcohol on a daily basis, and cleaning traps. One respondent, a farmer, who took high levels of precautionary measures, wore a full-faced mask and took all the precautionary measures that he could to ensure his safety.

The complexity of gauging the level of precautionary action arises when farmers and forest professionals are uncertain about when they can be potentially exposed and knowing which precautionary measures they were supposed to take under which potential exposure situations. This dilemma arises for farmers and forest professionals particularly when they find it impractical to be taking precautionary measures all the time. Thus, they attempt to make decisions about when it is safe to forgo taking precautionary measures and when they are suppose to take them.

SOME ADDITIONAL FINDINGS

The following sections of findings are not components or categories that emerged from the conceptual framework. However, they do have relevance to the study in terms of understanding the medium in which information can be communicated to farmers and forest professionals.

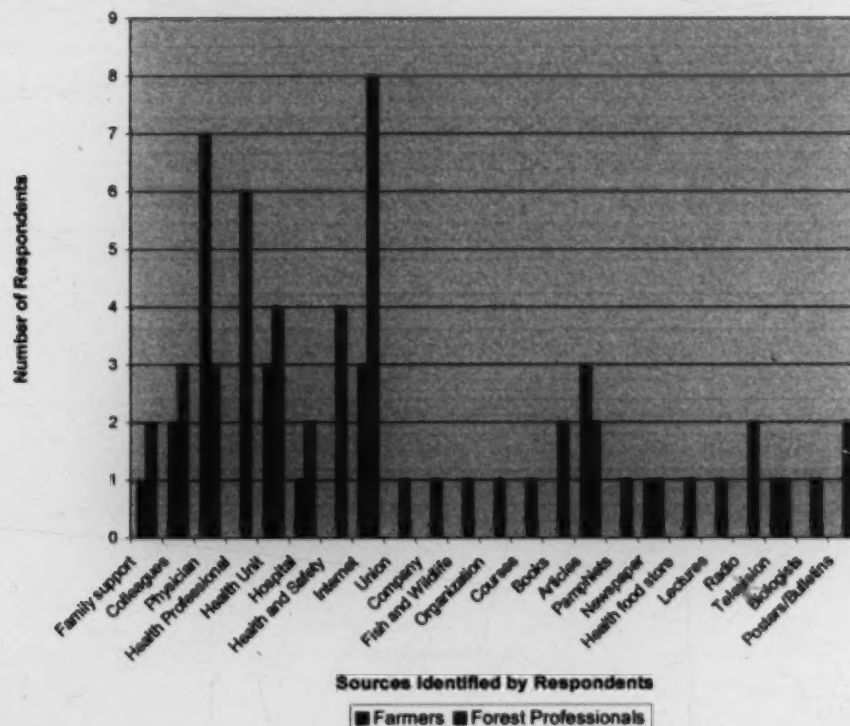
General Health Behavior

Respondents were asked to provide examples of sources and types of health information that they had accessed for themselves or someone else in the past year. They were also asked how often had they accessed health information in that year. This was for occupational and non-occupational health related information. If they had not accessed any health information in the past year then they were asked to describe any examples from the past few years. This question was posed to elicit an understanding of whether or not accessing health information was a routine for these individuals, the types of health information they would be accessing, as well as its sources. These questions specifically focused on their active process of acquiring knowledge.

A. Sources of Health Information

Figure 4-9 shows all the sources of health information where farmers and forest professionals actively acquired health information. The main sources of health information for seven of nine farmers were their physicians. A third of the farmers, three out of nine, said that their local health unit, internet, and articles published in agricultural periodicals or other farm related pamphlets were places they would most seek health information. Most forest professionals, eight out of eleven, said that they accessed health information through the internet. The other main sources identified by forest professionals were health professionals such as physicians, nurses, and pharmacists; their local health units; and their organisation's health and safety committee or program.

Figure 4-9. Sources of health information for farmers and forest professionals.

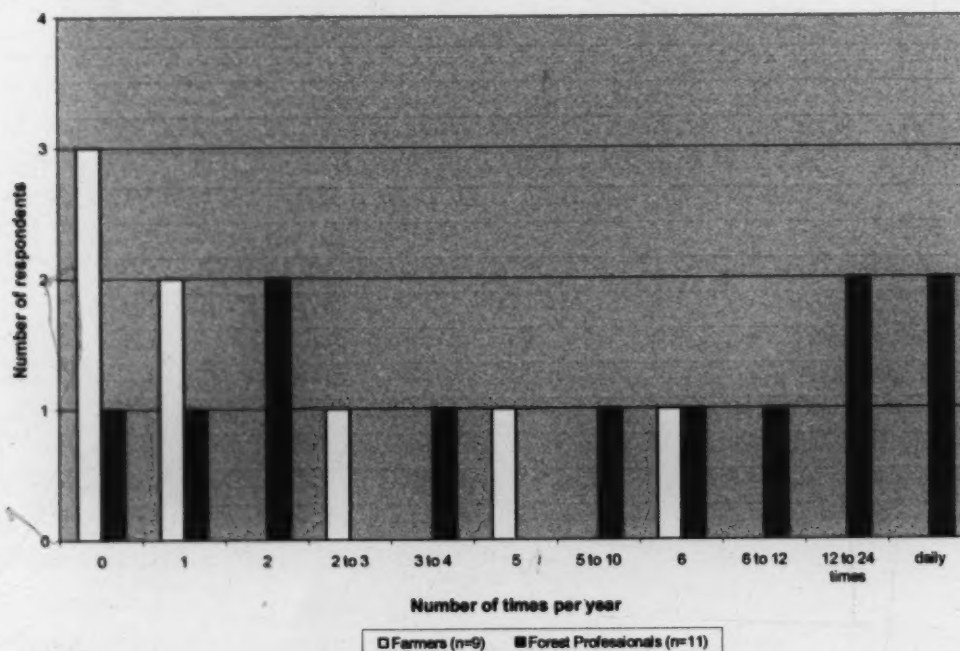


The main sources of health information for farmers were their physicians, followed by health units and the internet. Forest professionals mainly accessed health information through the internet. However, they also utilised health professionals.

B. Frequency of Accessing Health Information

An important factor was the frequency that these groups accessed health information. Refer to Figure 4-10. One third of the farmers interviewed, said that they had not accessed health information in the past year or past few years. It may be assumed that these individuals generally do not seek health information. One third of farmers recalled accessing health information once in the past year. The remaining three farmers each said they did so either two to three times, five times, or six times a year. Forest professionals tended to access health information on a more regular basis.

Figure 4-10. The number of times farmers and forest professionals accessed health information over a one-year period



These observations show that forest professionals actively accessed health information more frequently than farmers.

C. Types of Health Information that were Accessed

Farmers and forest professionals listed a number of different types of health information that they accessed in a one-year period. Table 4-6 lists examples of health information

that farmers and forest professionals sought. The first seven items listed for farmers are occupationally related health issues: cancer, chemical exposures, agricultural chemicals, water quality, health of livestock, planter's wart and arthritis. Two items were identified by farmers as non-occupationally related health issues: arthritis, and care of the elderly. Forest professionals were also concerned about cancer and chemical exposures. However, other occupationally related health concerns were air quality, safe working procedures, muscle strain, and vaccines. Other issues identified that contributed to overall general health were maintaining a healthy immune system and proper nutrition. These could be occupationally related since they contribute to a healthy worker. Salmonella poisoning and depression were said to be non-occupationally related health concerns.

Table 4-6. Examples of General Types of Health Information Sought by Farmers and Forest Professionals (not in order of importance)

<i>Examples of Health Information</i>	
<i>Farmers</i>	<i>Forest Professionals</i>
1. Various issues relating to cancer: • Specific types of cancer such as skin cancer • Sun exposure	1. Various issues relating to cancer: • Specific types of cancer such as brain tumors, esophageal cancer, and skin cancer • Cancer rates • Mortality rates • Sun exposure • Cancer treatment
2. Diseases and health effects associated with various chemical exposure	2. Diseases and health effects associated with various chemical exposure
3. Agricultural chemicals: • Overuse • Safe use procedures	3. Safe working procedures: • Chemical use • Using a chain saw • Issues related to driving long distances and for long periods of time • Regulation for employees working alone (that is, in field conditions)
4. Water quality	4. Air quality: • Building air quality • Asbestos exposure • Allergies
5. Health of livestock	5. Muscle strain
6. Planter's wart	6. Vaccines
7. Hantavirus	7. Maintaining a strong immune system
8. Arthritis	8. Nutrition: • Healthy eating
9. Care of elderly	9. Salmonella poisoning
	10. Depression: • Geriatric depression

Overall both farmers and forest professionals actively sought a range of health information in the past year. In many of these instances the types of health issues that

they were primarily concerned with were occupationally related. This indicated a consistent level of concern for health issues related to their jobs.

These findings provide some background to understanding the general behaviour of farmers and forest professionals when it comes to accessing information on health issues. We observe that although forest professionals accessed health information more frequently than farmers did, they both explored a wide range of occupationally related health concerns. Therefore, it may be concluded that both considered occupational health issues to be somewhat important. In addition, while farmers cited their physicians as the most important source of health information, forest professionals cited the internet as the most important.

CONCLUSION

This chapter illustrates the conceptual framework that emerged from the interviews with nine farmers and eleven forest professionals. The framework identified an interactive decision-making process in which individuals gauged the level of precautionary action. The following chapter discusses these findings.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

INTRODUCTION

This chapter will elaborate on the findings in chapter four. Comparisons are made between farmers and forest professionals in terms of their differences and similarities as identified in the conceptual framework. In addition, a comparison is made with the grounded theory conceptual framework and the other theoretical frameworks; namely risk perception and the health belief model. Applications of this conceptual framework are also discussed in the context of reducing risks for farmers and forest professionals.

COMPARISON BETWEEN FARMERS AND FOREST PROFESSIONALS

The differences and similarities between farmers and forest professionals are discussed in the following sections.

Differences between Farmers and Forest Professionals

Farmers and forest professionals both have unique work environments and job tasks. This uniqueness influences their potential exposures to the Sin Nombre virus (SNV). The following section discusses the differences observed between farmers and forest professionals, as well as the differences within the forest professional group.

A. Forest Professionals

Because of the nature of their jobs, forest professionals such as wildlife biologists, trappers, forest officers and technicians, tend to work in outdoor settings. For example, they work in the forest assessing the health of the trees, assessing the populations of wildlife in the forest, trapping these animals, or ensuring that forestry and wildlife laws and regulations are being followed. These individuals commute from point A to B in the forest either on foot, on all-terrain vehicles, on snowmobiles (in the winter), and where possible in trucks. Thus, for the most part they are working in open spaces. However, cabs of trucks do pose a potential location for deer mice habitation. In general though, it is their living environments that can pose a greater potential exposure to deer mice or their detritus. This is dependent upon whether the living environment is a permanent or temporary structure and whether they were living in field camps or in motels. If they

were living in permanent field camps they perceived their risk of exposure to be greater than if they were living in mobile trailers where they would be moving from one site to the next in a relatively short period of time, or if they were living in motels.

The forest technicians, forest officials, forest operations manager, and trappers rarely came across mice or their detritus except on some occasions in cabins, field camps, and cabs of trucks. Therefore, in most of their daily circumstances they had a relatively low level of exposure. The wildlife biologists, however, were directly in contact with deer mice because they were participating in biology projects that required trapping deer mice. This was also true for trappers. Although they may not have been trapping deer mice, the mice or their remains could have been present in their traps. Thus, for these wildlife biologists and on occasion the trappers, they were actually handling deer mice and their detritus. However for some, although they may have been directly handling deer mice, they still perceived their risk of exposure to hantavirus to be low, because they were working in an open environment.

All forest professionals had heard about someone who had contracted hantavirus either from the media or other sources. However, none of them had personally known anyone who had this disease. Therefore, there was no personal connection to an individual who had the disease. This factor also contributed to a lower perception of risk.

Forest professionals perceived farmers as having a greater occupational risk, because the nature of a farmer's job involved working in many enclosed spaces. Forest professionals generally perceived their level of exposure as low to moderate, even for those wildlife biologists who were handling mice on a regular basis. They chose no, little or moderate levels of precautionary action. All except three forest professionals said that they wore masks. Specifically they cited wearing dust masks. In addition, these three would not wear dust masks in all potential exposure situations. The wildlife biologist who did not wear one while handling mice felt there was no risk when the excreta were wet. He did wear the mask when cleaning traps, because that is when he felt there was potential to be exposed to dried excreta, which he could breathe in. The two forest officers said they would only wear dust masks if they were cleaning out an abandoned or dusty cabin or structure. The remainder said that they did not use any kind of mask, even if they were handling deer mice or their detritus. Many of them did,

however, wear gloves and sprayed down an area with a disinfectant before they cleaned it up.

B. Farmers

Farmers described the nature of their job as working in enclosed spaces such as cabs of tractors or grain trucks, in granaries, workshops and sheds, and food storage bins. These locations are not only enclosed, but also excellent habitat for mice. Mice can also be found in barns, wood piles, and in the crops. All of these locations are places where mice can nest and in some instances forage.

Farmers in general tend to see mice quite frequently on their farms, unless they keep cats on their farm, which they say keeps the mice populations low. Unlike forest professionals, farmers perceived a higher level of risk.

All farmers, like forest professionals, have heard about individuals who had contracted hantavirus. However, some farmers personally knew an individual who had either contracted the disease or died from it. Thus, the severity of the outcome and experience has greater meaning for farmers, because they can relate to the person who had hantavirus. That is, they can relate to how the victims became exposed, because they performed similar occupational tasks. Also, this person may have been a neighbour or a friend.

Similarities Between Farmers and Forest Professionals

Farmers and forest professionals both actively and passively sought information on hantavirus. However, the main sources were the media; specifically television and the radio, and colleagues. Thus, these would be appropriate vehicles to continue disseminating information on hantavirus.

Forest professionals and farmers were fairly knowledgeable about hantavirus and could recall and list a number of preventive measures described in various sources of hantavirus information. A study undertaken by Predy et. al. (1997) found respondents were relatively knowledgeable about hantavirus, although that study did not ask

respondents about their own preventive practices, because that was not the intent. In the present study there was an observed difference between knowledge and practice. The workers practised fewer precautionary measures than they were able to recall. Farmers and forest professionals found a number of barriers to taking precautionary measures. They questioned the effectiveness of some of the measures and described the lack of practicality of being able to use some of these measures in their work environment. As a result, the recommendation to wear the appropriate mask such as a HEPA filter or the P-100, R-100 or N-100 masks, was not taken because some farmers and forest professionals found they could not work with a mask on in field conditions and other work conditions. The mask became very uncomfortable if it was worn for an entire workday. The other precautionary measure that was difficult to use was wearing gloves when handling animals. However, this was not as big a deterrent as wearing the mask.

Farmers and forest professionals were concerned about knowing how to decide when would be the most appropriate time to take these precautionary measures. In an effort to resolve this uncertainty they would call local public health officers or other health officials. Much of the literature on hantavirus prevention measures is fairly generic and not specific to farmers' and forest professionals' job tasks. Therefore, they have difficulty in knowing when they should take certain precautions and the number of precautions they should take.

COMPARISON WITH OTHER THEORETICAL FRAMEWORKS

The conceptual framework generated in this study can be compared with Risk Perception theory and the Health Belief Model. It shows the interaction between concepts of risk perception and the Health Belief Model. Essentially it validates the Health Belief Model and concepts of risk perception by using grounded theory to explore an area of study which has not been previously examined.

Comparison with risk perception

In chapter three several elements for understanding risk perception were outlined. The elements that had some relevance to this study included controllability, familiarity, presence of alternatives, type and nature of consequences, availability of information,

personal involvement, memory of the consequence, and portrayal of risk in the media. Concepts of risk perception can modify behaviour and the way risk is managed. What is actually done to manage exposure to risk depends on whether they think it is threatening or whether they can do something about it (Osei et al, 1997).

A. Similarities with Risk Perception

One of the components of risk perception is the perception of controllability. It states that individuals believe that once a risk is under their personal control, then it is of less concern. However, individuals become more concerned and worried if they feel they do not have control over a risk. Controllability was observed in several places of this study. Individuals felt like they had control over potential exposure if they were simply aware of hantavirus. If they simply knew about hantavirus, how they could become exposed and the measures they should take, this was sufficient for some of them, because it gave them a sense of security. For others, besides being aware of hantavirus they felt it was imperative to actually take some precautionary measures. Thus, in taking these measures they felt that they could control their exposure to hantavirus. Still others felt that avoiding potentially "dangerous" situations was a good measure to take.

Another component of risk perception is that of familiarity. When an individual is familiar with a situation they are less concerned about their risk. This is unlike a risk that is perceived as unfamiliar. Examples in this study where familiarity contributed to less concern was in terms of the support that respondents received from peers. That is, farmers and forest professionals felt comfortable turning to their peers for advice on what their beliefs were about hantavirus, what precautions they should take, and which precautions seemed to work compared to ones that did not work. They turned to their colleagues, because they knew their peers would understand their situation since they were familiar with the occupational tasks performed and potential exposures.

Another example of familiarity in this study was observed with respondents' personal connections to individuals who had contracted hantavirus. However, in this case those who personally knew or were familiar with victims of hantavirus, were more concerned about hantavirus. They felt that if someone whom they knew, who lived in an area close by, or who was performing similar tasks to what one or one's family would perform, could

contract hantavirus, then the likelihood of them also contracting hantavirus under similar situations was perceived as great. This concept was only voiced by farmers who were personally familiar with individuals who had contracted hantavirus. Forest professionals were not personally familiar with anyone who had contracted hantavirus, and their level of concern about hantavirus was somewhat less. Although this example cannot be explained by the concept of "familiarity", it may be explained by the concept of "personal involvement". That is, if the consequence does not affect an individual directly, or if it is not in an individual's immediate vicinity, then the event is perceived to be less risky. This is the case with this study and it explains the level of concern related to the level of personal connection.

The "familiarity" concept held true when related to the familiarity with expected potential exposure as opposed to unexpected potential exposure. It was what some respondents referred to as "unexpected exposure situations". Both farmers and forest professionals felt confident that they could reduce their risk of exposure in certain situations where they knew they might encounter mice or their detritus. For example, a farmer going into a grain bin would consider this a likely place where he/she might encounter mice. Therefore, they could take some precautions like wearing a mask to reduce their potential risk of exposure. The grain bin is familiar to farmers as a place where they could be exposed. The problem arose when farmers or forest professionals were uncertain about potential places of risk. It was in these highly unfamiliar places that they were more concerned.

The nature of the consequence is another component of risk perception that is observed in this conceptual framework. That is, since a fair number of HPS cases are fatal, some individuals were highly concerned about hantavirus whereas others were not.

Another concept of risk perception was the presence of alternatives to the risky situation. If there are no practical alternatives in sight, many adverse conditions that are very risky are accepted and considered normal and less risky. This was observed with some of the farmers and forest professionals who suggested that exposure to deer mice was simply a job risk that they had to take. These individuals often took only minimal precautionary measures.

As more time passed from the 1993 incidence when there was much media focus and attention on hantavirus, individuals' memories of hantavirus begin to fade. Some respondents suggested they had not heard about any cases recently so hantavirus must not be an issue or a current health concern.

B. Differences with Risk Perception

Portrayal of risk in the media is another aspect of risk perception in the literature. Risk Perception theory says that individuals are extremely vulnerable to the portrayal of risks in the media. The way a news item is portrayed in the media will have a great influence on individual's perception of risk. For some of the respondents in this study, this phenomenon was certainly observed. They identified that the only time they heard about hantavirus on the media was when a death had occurred. The severity of the outcome for this disease made some of them considerably concerned about their own risks, so much so that some of them sought out additional information to try to understand their own occupational risks. However, some farmers and forest professionals felt that the media in fact had exaggerated the stories and they did not appreciate the "scare tactics" that were used by the media to inform the public about hantavirus. For others still, the media had no real effect on increasing their perception of risk. Their attitude was that hantavirus was simply a rare disease despite how deadly the media may have portrayed hantavirus to be. Thus, although some were highly affected by the media influences in terms of their perceptions of risk, others were not.

Therefore, some of the concepts of risk perception experienced the underlying motivations or factors that influenced how farmers and forest professionals gauged the level of precautionary action they should take. These concepts provided the linkages between the categories that emerged in the conceptual framework.

Health Belief Model

The Health Belief Model is one of the most widely used conceptual frameworks in health behaviour. It has been used both to explain change and maintenance of health behaviour and as a guiding framework for health behaviour interventions (Strecher & Rosenstock, 1997). Within the Health Belief Model (HBM) the purpose or outcome of this

model is to address the issue of the likelihood of taking recommended preventive health action (Becker et al., 1977).

It is believed that individuals will take action (cues to action) to prevent, to screen for, or to control an ill-health condition if they regard themselves as susceptible to the condition (perceived susceptibility). They will also take action if they believe the condition to have potentially serious consequences (perceived severity); or if they believe that a course of action available to them would be beneficial in reducing either their susceptibility or severity of the condition (perceived benefits). In addition, if they believe that the anticipated barriers (e.g. costs, difficulty in understanding or using prevention information) to taking action are outweighed by the benefits, then they will also take action. Finally, an individual will take action when one has the confidence in one's ability to successfully take action (self-efficacy) (Strecher & Rosenstock, 1997).

Two major factors influence the likelihood that a person will adopt a recommended preventive health action. First they must feel personally threatened by the disease (that is, they must feel personally susceptible to a disease with serious and severe consequences). Second, they must believe that the benefits of taking the preventive action outweigh the perceived barriers to preventive action (Maiman & Becker, 1974).

A. Similarities with the Health Belief Model

Perceived susceptibility is essentially one's subjective perception of the risk of contracting a certain condition, in this case, hantavirus. Both farmers and forest professionals expressed their perceptions of risk, and their perceptions of susceptibility varied depending on their level of exposure and affiliation with cases.

Another factor in the health belief model is the notion of perceived severity. This is an individual's feeling concerning the seriousness of contracting an illness or disease. Generally, low perceptions of seriousness might provide insufficient motivation for behaviour; while very high perceptions of seriousness might promote action. Farmers and forest professionals were aware of the seriousness or severity of outcome for an individual who contracted hantavirus, that is death. However, for some their perception of the seriousness of the disease was low and this perception contributed to taking little

or no precautionary action. Thus, their motivation to action was low. Those who perceived the seriousness to be quite high were more motivated to take action.

Another component is their perceived benefits. This is their belief in the effectiveness of the various actions available to reduce the disease threat. Farmers and forest professionals who took low, moderate or high levels of precautionary action did so because they believed that it would reduce their potential exposure. This belief empowered them and provided them with a sense of control over their potential exposures. Those who took no or only little precautionary action did so because either they felt they had little or no exposure to hantavirus or because they questioned the efficacy of certain protective measures. Thus, the barriers outweighed the benefits.

Another component is the perceived barriers. This is the potential negative aspects of a particular health action that may act as impediments to undertaking the recommended behaviour. Farmers and forest professionals both described this aspect when they relayed their stories of the practicality in using certain precautionary measures such as respiratory masks and gloves.

A cue to action, such as mass media campaigns, advice from others, reminder postcards from physician or dentist, illness of family member or friend, newspaper or magazine articles, is another component of the Health Belief Model. These stimuli are intended to trigger the decision-making process. In this study the media, support from colleagues and soliciting information from health officials were in some cases cues to action. If these sources increased one's perception of susceptibility to the disease then individuals responded to these cues by taking precautions. However, in the opposite situation individuals responded to the cues by not taking actions. This was confirmed in this study.

B. Differences with the Health Belief Model

However, a factor that is not supported by the health belief model is one that is related to individual's previous experiences. This phenomenon directly influenced their behaviour in terms of whether or not they were going to take precautionary actions. A limitation of the health belief model is that factors other than health beliefs can also influence health

behaviour practices. Farmers and forest professionals alike talked about experiences when they were younger handling numerous mice, or when they were worked in conditions with high exposure to deer mice. In these instances they did not contract hantavirus. Thus, if they had been in contact with hantavirus on all these occasions and did not get it, their assumption was that their likelihood of getting it in the future are also slim. As a result these individuals did not deem it necessary to take any precautionary measures.

Overall, most of the categories and their components generated in the conceptual framework can be explained within the theoretical frameworks of risk perception and the health belief model. However, the conceptual framework does validate the theoretical frameworks of risk perception and the health belief model.

While this conceptual framework may not be completely unique from those of risk perception and the health belief model, it is substantive in that it speaks specifically about the populations and context within which it was studied. As a result it has unique applications to these particular populations. This is particularly important since there have been no previous studies in the area of hantavirus prevention that have addressed the issue of how individuals decide the level of precautionary action they are going to take.

APPLICATIONS OF THE CONCEPTUAL THEORY IN REDUCING RISK

The most important application of this conceptual framework is that it provides an understanding of how farmers and forest professionals decide on the level of precautionary action they are going to take. This decision-making process is influenced by a number of factors. Although the conceptual framework focused on a decision-making process which describes how farmers and forest professionals gauge the level of precautionary action, it did not primarily focus on precautionary measures as a means of contributing to risk reduction. However, components within the categories of this conceptual framework identify several applications of this study relevant to reducing the risks of hantavirus for farmers and forest professionals in Alberta.

Understanding Hantavirus

One of the main categories in the conceptual framework, understanding hantavirus, identified the media coverage and support from colleagues as two influences of information sources on respondents. These factors are important components influencing risk reduction for farmers and forest professionals.

Media coverage of hantavirus information is an important avenue for disseminating this information. Farmers and forest professionals both identified media sources such as television, radio, and newspapers as three main ways that they recalled hearing about hantavirus. Timing of the media coverage was another important aspect identified. Farmers and forest professionals both recalled hearing about hantavirus news stories usually in the spring and the fall. They felt these were important times for this type of information to be disseminated because these were also times when farmers and forest professionals are performing occupational tasks, which may increase their level of exposure. Some recalled hearing these media stories and said that it reminded them to be careful while working in areas of potentially high exposures to deer mice. Targeting hantavirus information dissemination also makes sense when one observes that it is during the months of May and October when the greatest number of HPS cases have occurred in Alberta. For one farmer who contracted HPS (FA 25), the information about potential exposures, and signs and symptoms which he recalled from a media coverage may have contributed to him seeking appropriate medical attention. Although he recalled hearing about the precautionary measures for hantavirus, he did not take precautions when cleaning a mouse-infested tractor cab. The first physician he visited said that he had the flu. However, upon returning home he recalled the hantavirus media story and wondered whether he could have hantavirus. He then phoned his regular family physician and explained the activities he had been undertaking and his suspicions about hantavirus. His regular physician then sent him directly to the University of Alberta Hospital. Thus, his recollection of this media coverage may have contributed to him taking some appropriate action in dealing with his situation.

However, an interview with a health official from Alberta Health and Wellness said that there were plans to discontinue disseminating their spring hantavirus warning message because they felt it was not an effective tool in reducing risk. A recommendation from this study is to continue disseminating hantavirus information, particularly through media

coverage in the spring and the fall. The respondents found these to be useful and felt that they reduced risks for farmers and forest professionals.

Support from colleagues is a medium through which colleagues can discuss their opinions about hantavirus; a forum for sharing their experiences with using precautionary measures and identifying what is effective and practical to use while working. It is also a vehicle for communicating their concerns and having them heard. There is a level of trust, comfort, and familiarity with colleagues that makes this an effective process of not only communicating hantavirus information but also providing support.

Assessing One's Potential Exposure

Some farmers and forest professionals talked about prioritising their risks. Many said that there were so many diseases or occupational hazards that a farmer or forest professional could be exposed to that it was not possible to think about all the possible occupational risks and deal with all of them. One approach to this dilemma could be to recommend the ability of one set of precautionary measures in protecting an individual from other potential diseases or illnesses, including hantavirus. The assumption here is that not all diseases can be prevented by taking one or two precautionary measures, but rather that those which similar preventive measures may reduce the risk for more than one disease, should perhaps be identified. The idea of being effective in one's health behaviour in more than one way may be appealing to individuals especially if they feel that there are so many diseases or illnesses that could affect them. Rather than leaving individuals to feel helpless that there are so many aspects of safety on their job to worry about, assisting them with being health and safety conscious in general in their work environment may be beneficial.

Some farmers and forest professionals had identified this idea of taking one preventive measure to protect against more than one disease or health condition when they talked about some of the reasons that they took preventive measures against hantavirus or in general. Two wildlife biologists said that they wore gloves while working with mice to protect themselves from being bitten. One of them suggested that the reason he "wore latex gloves over cotton gloves was not necessarily to protect against hantavirus, but to

prevent from being bitten by the mice" (FP 1). He also said that this procedure provided "extra warmth when out in cold and/or wet conditions" (FP 1).

The trappers said that they wore rubber gloves while trapping because this not only lowered their chances of getting a disease from the animals, but also so that their scent did not get onto their traps deterring animals from going into their traps. Thus, they saw using the gloves as having more than one advantage. One of the trappers suggested that he wore latex gloves when skinning the animal to protect against any diseases that the animal might have from being transmitted to him. This he thought was especially necessary if he had cuts or bruised skin while handling these animals. But he felt using latex gloves rather than rubber gloves in this case also helped him to work with the animal more easily.

A few farmers suggested wearing dust masks to reduce the amount of dust they breathe while doing various farm tasks where there is a lot of dust involved. They mentioned that this would help with diseases like farmers lung or even allergies. In fact, one farmer said that he, "didn't think farmers are taking precautionary measures specifically against hantavirus. But they are wearing masks to protect themselves from inhaling dust and dust particles" (FA 16).

Thus, a recommendation is to communicate the benefits of using masks, gloves, and other precautionary measures suggested for hantavirus risk reduction, in terms of reducing the risks for other diseases including hantavirus.

Dealing with Potential Exposures

A number of farmers and forest professionals described the difficulties they and their peers had with using some of the recommended precautionary measures. For many it was not practical to take certain precautionary measures recommended in some media coverage, various documents, health professionals, and occupational health and safety committees and groups. Both groups generally did take some level of precautions, particularly spraying down an area with disinfectant before cleaning and cleaning up any mouse detritus. The measures they had the most difficulty with were using the appropriate respiratory mask, as well as in some cases wearing gloves, and goggles. It

inhibited their work process and was generally too uncomfortable to wear particularly for long periods of time. Thus, one recommendation is to assist farmers in identifying occupational tasks where they would be of higher risk to hantavirus exposure and then producing a job safety analysis for these tasks. For example, the job safety analysis could include identifying what precautionary measures one should take when working in granaries, cabs of vehicles, handling mice in the field.

ANOTHER APPLICATION OF THE CONCEPTUAL FRAMEWORK

The following recommendation is indirectly related to reducing risk of exposures for farmers and forest professionals.

Establishing Support Mechanisms

Support for the farmers who had contracted hantavirus is another recommendation that is an important application of the findings from the conceptual framework. Farmers who had hantavirus communicated the often intense psychological effects the disease had on them. They talked about how they and their families coped with the disease and their near death experience. They also questioned how they contracted the virus, and whether they could contract it again. It was suggested by one of the farmers that he would have really liked to talk to others who had the disease. He felt that being able to share his experience with others might have helped him cope with what had happened but also to share information about the disease, and cope with going back to the environment where the potential exposure was still present. Thus, a recommendation is that support mechanisms be established for those who have contracted hantavirus, their families, and those who have lost a family member to hantavirus.

LIMITATIONS OF THIS STUDY

In two of the initial interviews, the interviewer's approach to conducting the interviews was relatively formal. The dilemma was trying to maintain a balance between showing the credibility and confidential nature of the interview as well as eliciting the experiences

of farmers and forest professionals. In doing so, unfortunately, the overall tone of the interview became too formal. As a result this may have hindered the conversation and sharing of ideas between the interviewee and interviewer. Upon reviewing the audiotapes prior to the next interviews, this interviewer recognised that the manner in which the interviews were being carried out needed to be changed to one that was more conversation-like and informal.

Another limitation of this study is that a wider variety of forest professionals was not included in this study. For example, although having tried, the researcher was unable to recruit forest professionals such as feller/buncher operators (those who cut the trees, remove the branches and stack the logs for transportation), skidder operators (those who transport the logs to the mill), and various sawmill workers. These individuals may have been able to provide other perspectives for the forest professional group, which were not captured in this conceptual framework.

A third limitation of this study is that it asked respondents to recall information about sources and content of information from which they heard about hantavirus. This sometimes required respondents to recall events from years prior. Thus, the depth of information may not have been ascertained from these individuals because they may not have been able to fully recall events or content.

CONCLUSIONS

Hantavirus Pulmonary Syndrome (HPS) is a rare disease in Canada. However, the high rate of mortality makes this an important disease to study. Prevention was chosen as the focus for this study because there is limited research done in this area and because there is no treatment for the disease if one contracts it, except for supportive care.

This research study used grounded theory methodology for data collection and data analysis to uncover the decision-making process used by farmers and forest professionals in gauging the level of precautionary action they should take when faced with potential exposures to deer mice and their detritus. Although the initial intent of this study was to develop theory that focused on reducing the risks of hantavirus for farmers and forest professionals, the respondents identified a decision-making process as their main concern. Through the barriers and other factors identified in this conceptual framework, recommendations regarding risk reduction for farmers and forest professionals were addressed.

The conceptual framework developed through the grounded theory data collection and analysis process identified four main categories that contributed to a decision-making process. The central category is gauging the level of precautionary action. In this process farmers and forest professionals decided on the level of precautionary action they would take for the particular potential exposure situation they were facing. The other categories, sub-categories and their properties that emerged from the data influenced this decision. The other three main categories that guided this decision-making process were related to the farmer's or forest professional's understanding of hantavirus, their assessment of the potential exposure and how they dealt with potential exposures.

The conceptual framework that emerged from the data showed similarities to the existing theoretical frameworks of risk perception and the health belief model. However, the value in this conceptual framework is its substantive nature in that it speaks specifically of the farmers and forest professionals studied and the context within which they were studied. Some applications of this conceptual framework determined ways of reducing

the risks for farmers and forest professionals in Alberta. These included applications for future planning and future research.

Applications for Future Planning

1. Timing of hantavirus information dissemination
 - Continue disseminating information in the spring and fall
2. "Piggy-backing" precautionary measures
 - Promote the idea of multi-purpose preventive measures: prevention against hantavirus and other diseases or conditions
3. Establish a support group for those who have contracted hantavirus and their families
 - Ways of providing support
 - Venue to communicate information on hantavirus and precautionary measures

Future Research

1. Identify precautionary measures for specific occupational tasks
 - Develop job safety analysis for specific occupational tasks
2. Test the practicality of these specific precautionary measures

These recommendations can be used to reduce the risk of occupational exposure for farmers and forest professionals in Alberta's boreal forest.

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APPENDIX A: INTERVIEW GUIDE FOR FARMERS AND FOREST PROFESSIONALS

Hantavirus Interview Guide For Farmers and Forest Professionals

I. Obtain Consent

In a face-to-face interview, I will provide the information sheet and consent form for the respondent to read over, ask any questions, and then sign the consent form if they give consent.

In a telephone interview, I will read the information sheet, ask if they have any questions, read the consent form and ask if they have any questions. And then ask for a verbal consent which will be taped on an audio-tape.

II. Personal Information

1. Name: _____
2. Day and Date of Interview (dd/mm/yy): _____
3. Occupation: _____
4. What do you do if you have questions about health matters?
(List of Options)
 - Physicians, local clinics, local health centres, local health officials, internet, newspaper, television, radio, magazines, etc.
 - Where do you usually get answers to questions about health?
 - How often do you access health information in the past year?
 - What are some examples of health information you have looked for?

III. Information About Hantavirus

1. What can you tell me about hantavirus?
2. Where did you hear about hantavirus?
 - What format did you receive this information in (television, radio, newspaper, family, friends, neighbours, etc.)?

IV. Preventive Measures Information

1. What information did [the name of the source] on how you can protect yourself from getting hantavirus?
 - Do you know of any ways you can protect yourself from hantavirus exposure? If yes, describe them.
 - Did the information satisfy your needs? (Was the information helpful? Why or why not?)
2. Did you use any of the prevention information/take any of the precautions suggested?
 - If no, what are some of the reasons why you are not using this information (barriers to the use of this information)?
 - If only sometimes use it, what are the reasons why you are not using it all the time?
3. Describe how you used this prevention information.
 - What was your experience using this prevention information?

V. Exposure Information

1. Describe a typical work day in the field/on the farm?
 - Probe for information on whether working outdoors, in buildings, etc.
2. Have you ever had any experiences with mice, mice droppings or nests (show the picture of a deer mouse—if doing a face-to-face interview)?
3. If yes, describe what were your experiences with deer mice?
 - (If doing a telephone interview) What do the mice look like?
 - Have you seen many? How often have you seen them?
 - Where have you seen these mice, their droppings, and/or nests?
 - When do you see seen mice, mice droppings, and/or nests?

4. When, on the job, do you think you are most or at greatest risk of exposure to hantavirus? Describe the situation you would be in.
5. When, on the job, do you think you are least or at lowest risk of exposure to hantavirus? Describe the situation you would be in.

VI. Risk Perception

1. Are you concerned about hantavirus? Why or why not?
 - If you are concerned about hantavirus, what are your concerns?
2. Do you know anyone who has been affected by hantavirus?
3. Have you heard of anyone being affected by hantavirus? Describe what you heard? When? Where?

Perceptions of control over hantavirus exposure

1. Do you feel you have much control over avoiding harmful effects of hantavirus? Why or why not?
If yes, what kind of control do you feel you have?
2. Do you feel you have control over avoiding the amount of hantavirus that you may be exposed to? Why or why not?
If yes, what kind of control do you feel you have?

Optimistic Bias

1. What do you think are the chances that a farmer or forest professional would experience adverse effects in the future as a result of exposure to hantavirus?
 - 1) No chance
 - 2) Somewhat likely
 - 3) Very likely
 - 4) Definitely likely

Why?

2. Do you believe that you may experience some health effects in the future as a result of hantavirus exposure?

- 1) No chance
- 2) Somewhat likely
- 3) Very likely
- 4) Definitely likely

Why?

Perceived voluntary nature of hantavirus exposure

1. How difficult would it be to find another job outside of farming/forestry, etc.?

- 1) Not difficult
- 2) Somewhat difficult
- 3) Very difficult
- 4) Impossible

2. Do you expect farming/forestry work will be your major source of income in the next year? _____

Action

1. What recommendations or suggestions would you make to get farmers or forest professionals to be more aware of hantavirus?

2. What recommendations or suggestions would you make to get farmers or forest professionals to use preventive measures?

3. Where would be the best places to inform farmers or forest professionals on issues of hantavirus and its prevention?

APPENDIX B: INTERVIEW GUIDE FOR GOVERNMENT OFFICIALS

Hantavirus Interview Guide For Government Officials

I. Obtain consent

In a face-to-face interview, I will provide the information sheet and consent form for the respondent to read over, ask any questions, and then sign the consent form if they give consent.

In a telephone interview, I will read the information sheet, ask if they have any questions, read the consent form and ask if they have any questions. And then ask for a verbal consent which will be taped on an audio-tape.

II. Personal Information

Name: _____

Date of Interview (dd/mm/yy): _____

Occupational Title: _____

III. Information on Hantavirus

1. What is the content of information available on hantavirus for the general public?
2. How is the information on hantavirus being targeted? Why?
3. How can a farmer or forest professional gain access to information on hantavirus?
 - Where would you recommend they look for this information?
4. What types of preventive measures are suggested?
5. Would you say these same measures are applicable for farmers and forest professionals? Why/how?
6. Do you think these occupational groups are accessing information on hantavirus? Why?

7. Do you think that they are using these preventive measures/strategies? Why?
8. If you don't think that they are using this information, what would you recommend as ways of getting farmers and forest professionals to use these preventive measures that you and other health officials suggest?

APPENDIX C: INFORMATION SHEET

Information Sheet

Hantavirus in Alberta's Boreal Forest: Reducing the Occupational Health Risk of Exposure for Farmers and Forest Professionals

Principle Investigator: Komali Naidoo (780) 462-1765

Email address: knaidoo@compusmart.ab.ca

Co-investigator: Dr. Nancy Gibson (780) 492-3883

Purpose of the study:

The goal is to reduce farmers' and forest professionals' risk of exposure to hantavirus. This study and its results will be used in my Master's work at the University of Alberta.

Hantavirus is a rare disease in Canada. To date, there are 20 cases of hantavirus in Alberta. All of which are from rural Alberta. One-third of these cases was fatal. It affects only a small number of people who come in contact with the virus. But, it can be fatal in about one-third of those who develop the disease, if not treated. There is no specific cure. Thus, reducing one's exposure to the virus is key.

There are many sources addressing issues of hantavirus and hantavirus prevention. However, little is known about the usefulness of this information and peoples' perceptions of hantavirus risk in Alberta.

This study will find out:

- What one knows about hantavirus.
- What one knows about getting hantavirus.
- Where one has heard about hantavirus.
- How one prevents getting hantavirus.
- How useful was the information on preventive measures.

These issues will be addressed by interviewing you, and other farmers, forest professionals and health officials. The information you provide will help make

recommendations to reduce the risk of hantavirus exposure for farmers and forest professionals working in Alberta.

The interview will take about an hour. **Your participation is voluntary. You are free to withdraw from this study at any time. And there will be no consequences.** You will not be identified by name, only by a number. Thus, your identity will not be revealed at any time. The interview information will be kept in a secure area for seven years after the study has been completed. Komali Naidoo and her supervisor, Dr. Nancy Gibson, are the only people who will have access to this data. If any more work is done with this study, further ethics approval will be sought first.

For more information please contact Komali Naidoo at (780) 462-1765 or Dr. Nancy Gibson at (780) 492-3883. If you have any concerns about this study you may contact Karen Turpin, Administrative Assistant, Health Research Ethics Board (University of Alberta) at (780) 492-0839.

Thank you for being a part of this study.

APPENDIX D: CONSENT FORM

Consent Form

Hantavirus in Alberta's Boreal Forest: Reducing the Occupational Health Risk of Exposure for Farmers and Forest Professionals

Principal investigator: Komali Naidoo, (780) 462-1765

Department of Public Health Sciences

13-103 Clinical Sciences Building

University of Alberta, Edmonton, AB, T6G 2G3

E-mail: knaidoo@compusmart.ab.ca

Co-Investigator: Dr. Nancy Gibson, (780) 492-3883

Department of Human Ecology,

3-02 Human Ecology Building

University of Alberta, Edmonton, AB, T6N 2N1

E-mail: nancy.gibson@ualberta.ca

Do you understand that you have been asked to be in a research study? Yes No

Have you read and received a copy of the attached Information Sheet? Yes No

Do you understand the benefits and risks involved in taking part in this research study? Yes No

Have you had an opportunity to ask questions and discuss this study? Yes No

Do you understand that you are free to refuse to participate or withdraw from the study at any time? You do not have to give a reason. Yes No

Has the issue of confidentiality been explained to you? Yes No

Do you understand who will have access to your interview information? Yes No

Do you give permission to have the interview taped audio-taped? Yes No

This study was explained to me by:

I agree to take part in this study.

Signature of Research Participant

Date

Signature of Witness

Printed Name of Research Participant

Printed Name of Witness

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator or Designee

Date

**THE INFORMATION SHEET MUST BE ATTACHED TO THIS CONSENT FORM AND A COPY
GIVEN TO THE RESEARCH SUBJECT.**